Urban Small Farms Conference 2019

Thrusday, February 21st, 2019

Time	Water Issues
1:00	How to Take, Test, and Understand Water Samples - Grant Cardon, USU **pg. 228**
1:30	Water Rights 101 - James Greer, Utah Division of Water Rights **pg. 229**
2:00	Water Incentive and Conservation Programs - David Rice, Weber Basin Water Conservancy District **pg. 233**
2:30 - 3:00 Break	
3:00	Water Outlook, Conservation, and Trends - Rick Maloy, Central Utah Water Concervancy District **pg. 241**
3:30	Drip Irrigation Systems: Design and Installation - Dale Allred **pg. 253**
4:00	Drip Irrigations Systems: Scheduling, Operation, and Maintenance - Niel Allen, USU **pg. 254**
4:30	Experience with Drip Irrigation - Chris Natalie, New Roots SLC **pg. 262**

Click on a session you would like to view and it will take you there!

Back to Top

How to Take, Test, and Understand Water Samples

Grant will discuss proper irrigation water sampling, and outline key water quality analyses and their interpretations with respect to irrigation use.

Grant Cardon
Extension Soils Specialist
USU Plants, Soils and Climate Department
grant.cardon@usu.edu

A USU alum, Grant has had career stops with the USDA, Colorado State University, and now back at USU over his 28 years working in soil fertility, salinity and irrigation management. Grant, and his wife Kay Lyn are the parents of four married children, gracing them with 10 awesome grandchildren...and counting! Grant's interests outside of USU are sports, science fiction reading, gardening, music, and online news consumption.

Back to Top

Water Rights 101

An overview of Utah water right law.

James Greer
Assistant State Engineer
Utah Division of Water Rights
jamesgreer@utah.gov

I am the assistant state engineer over the technical services section of the Utah Division of Water Rights.

Water Rights

101

James Greer
Utah Division of Water Rights
February 21, 2019

Brigham Young

<u>September 30, 1848</u>

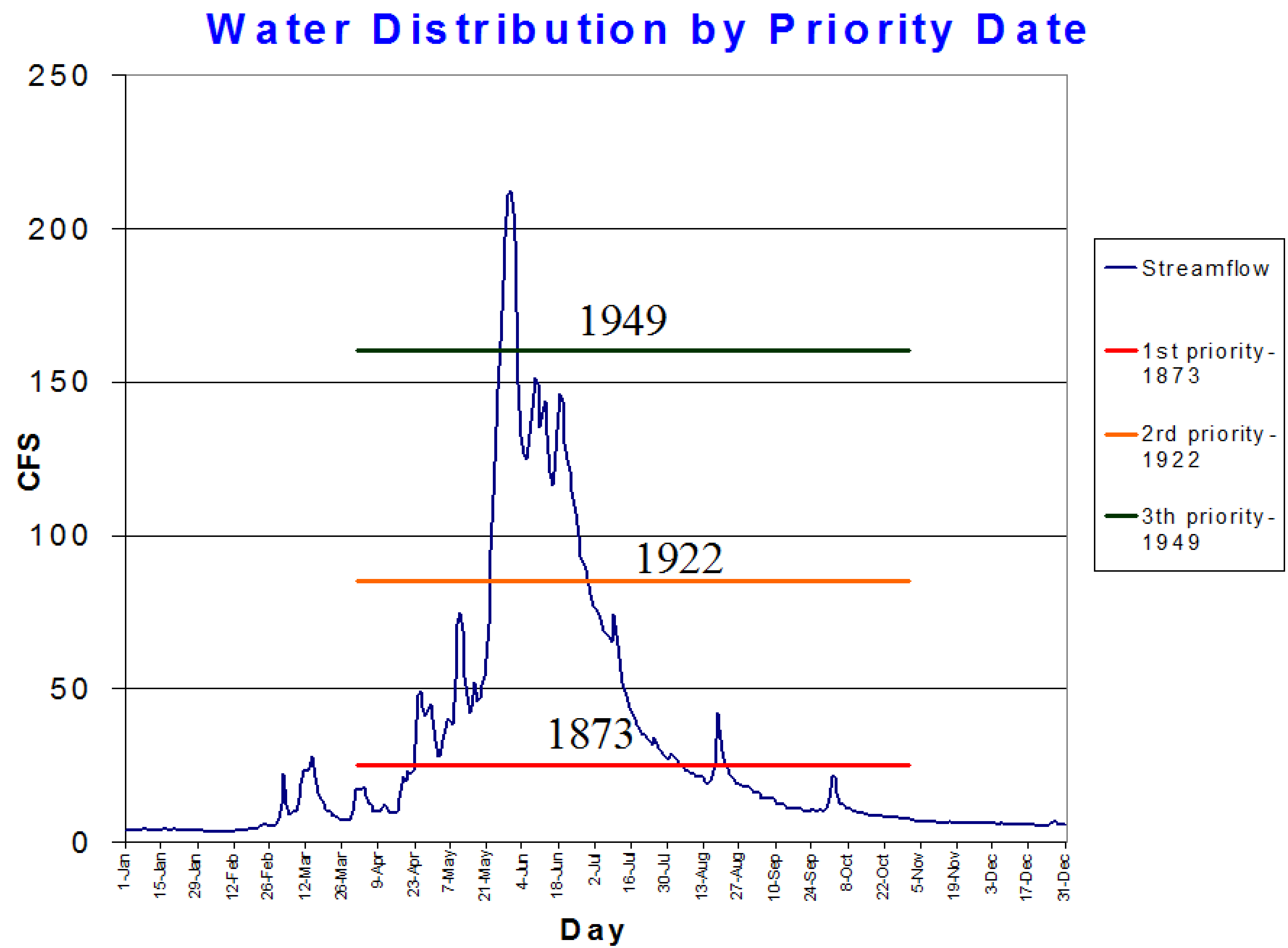
"There shall be no private ownership of the streams that come out of the canyons... These belong to the people: all the people."

Utah Water Law
1903

- Water is the property of the public (73-1-1)
- Rights to use for beneficial purposes (73-1-3)
- Beneficial use promotes public trust purposes (73-1-5)
- Water Distributed by Priority (73-3-21.1)
- Ability to change rights to new uses (73-3-3)
- Failure to use beneficially / loose right (73-1-4)

Diversion vs. Depletion

- **DIVERSION** is removal of water from its natural source whether it is surface or groundwater and applied for its beneficial use. It can be limited by flow or volume.
- **DEPLETION** is the portion of water withdrawn from a surface or groundwater source that is consumed by a particular use and does not return to a natural water source or another body of water.



Water Distribution by Priority Date
CFS
250
200
150
100
50
0
1949
1922
1873
1-Jan
15-Jan
29-Jan
12-Feb
26-Feb
12-Mar
26-Mar
9-Apr
23-Apr
7-May
21-May
4-Jun
18-Jun
2-Jul
16-Jul
30-Jul
13-Aug
27-Aug
10-Sep
24-Sep
8-Oct
22-Oct
5-Nov
19-Nov
3-Dec
17-Dec
31-Dec
Day
Streamflow
1st priority-1873
2rd priority-1922
3th priority-1949

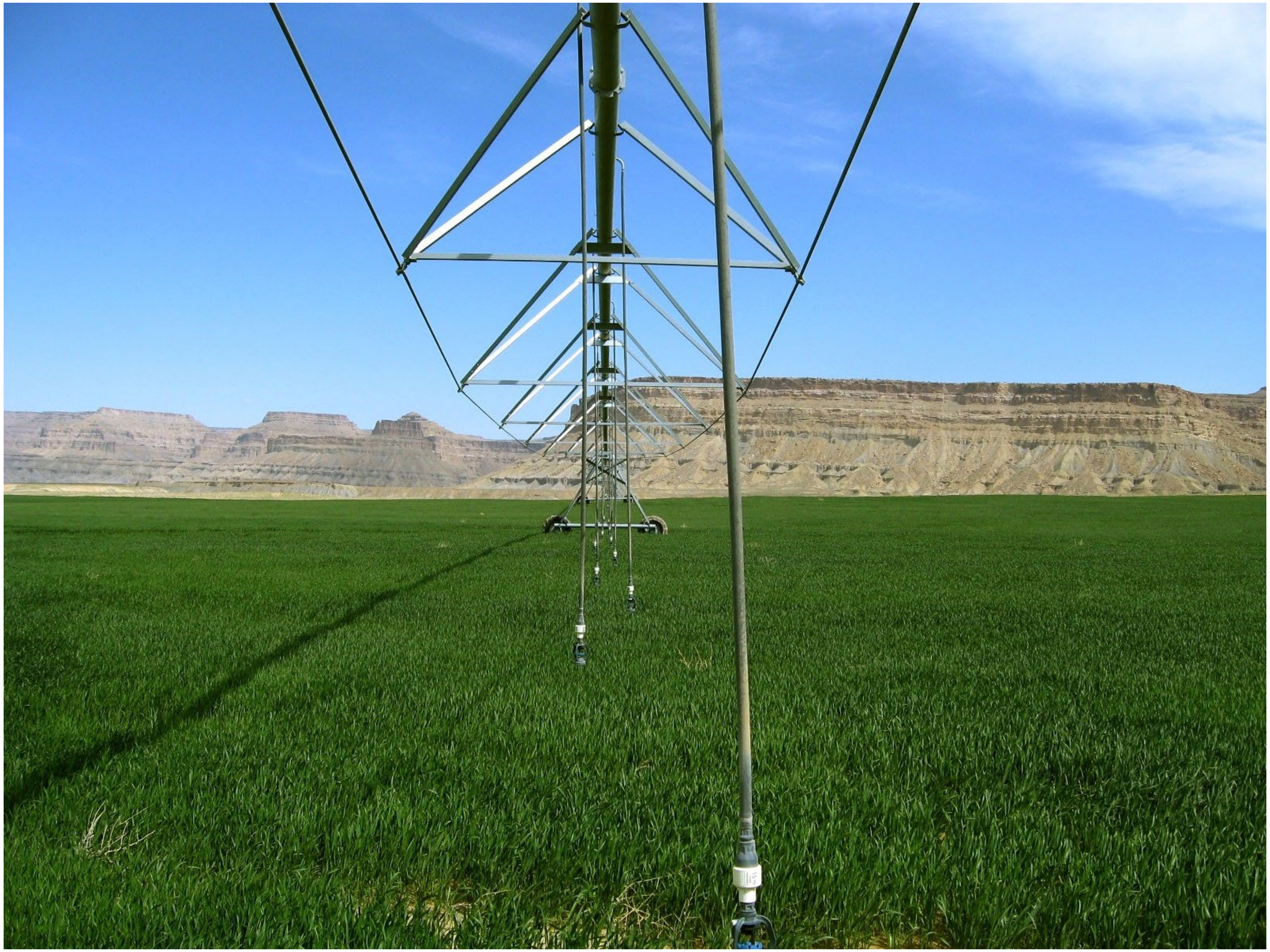
Public Policy Against Waste

- Utah is an arid state and the conservation of water is of the first importance. It has always been the public policy of this state to prevent the waste of water.
  - » Big Cottonwood Tanner Ditch Co v Moyle (1945)

Beneficial use shall be the basis,
the measure
and the limit
of all rights to the use of water

WHAT IS WATER CONSERVATION?

WHAT HAPPENS TO CONSERVED WATER?



CAN WATER BE STORED?

CONSERVATION VS EFFICIENCY?

Questions

Water Incentive and Conservation Programs

This presentation will focus on current incentives available to assist in achieving a reduction in water use. It will also cover a general overview of conservation programs that are in effect and available to help water users of all types to reduce excess water use and achieve water supply goals for the future.

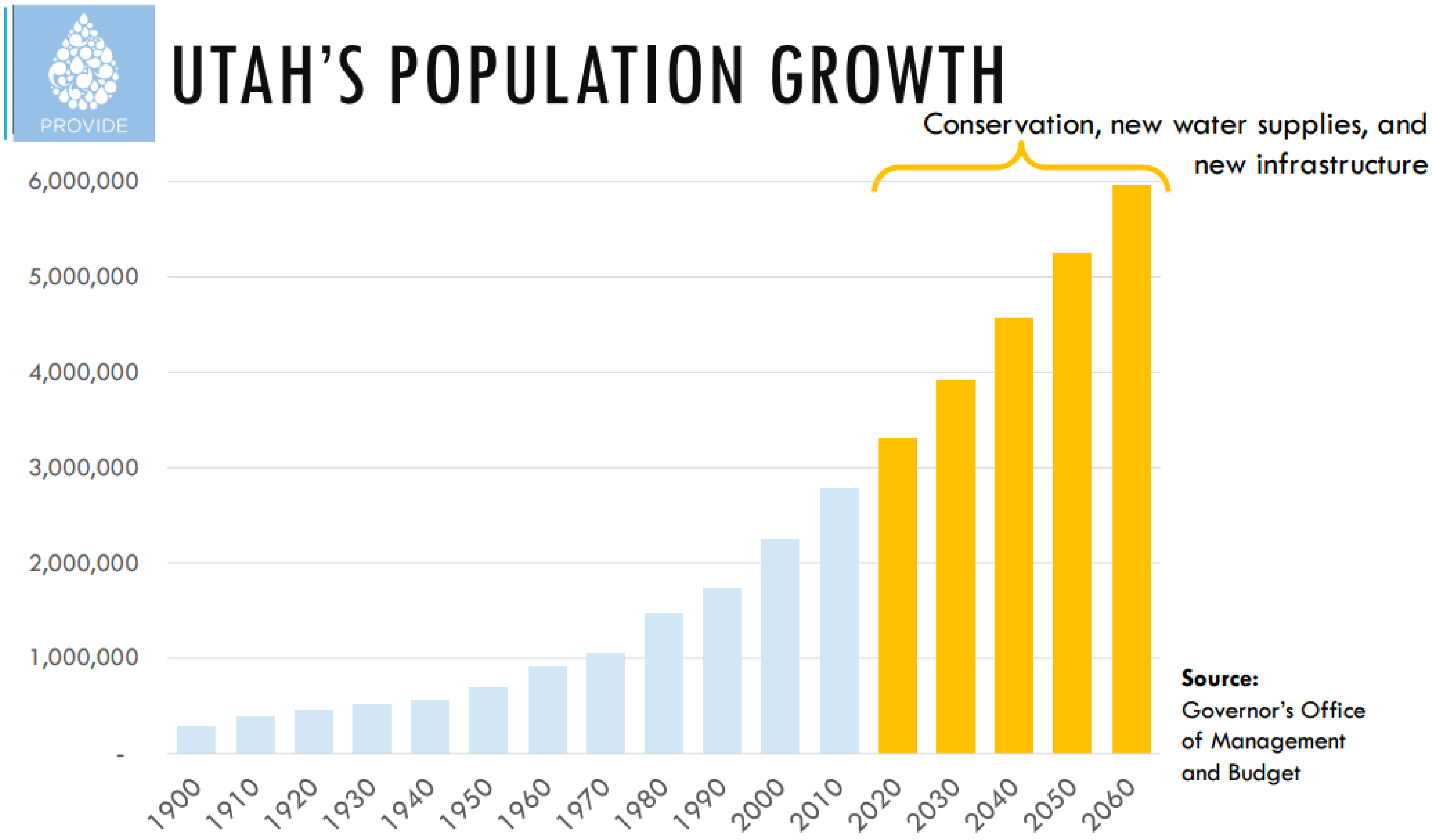
David Rice
Conservation Programs Coordinator
Weber Basin Water Conservancy District
drice@weberbasin.com

I have worked in water conservation for over 15 years with Jordan Valley Water District and Weber Basin Water District. I have a masters degree in Horticulture from USU with an emphasis on Low Water Landscaping. I have been coordinating and managing conservation programs of all types over the tenure of my working career. Currently working with Weber Basin, the emphasis is focused on secondary water meters and bringing personal water use accountability to all secondary water users. Public education, rebates, water audits, ordinances and other programs all play a role in changing public perception and more importantly behavior when it comes to water use for all the varied needs.

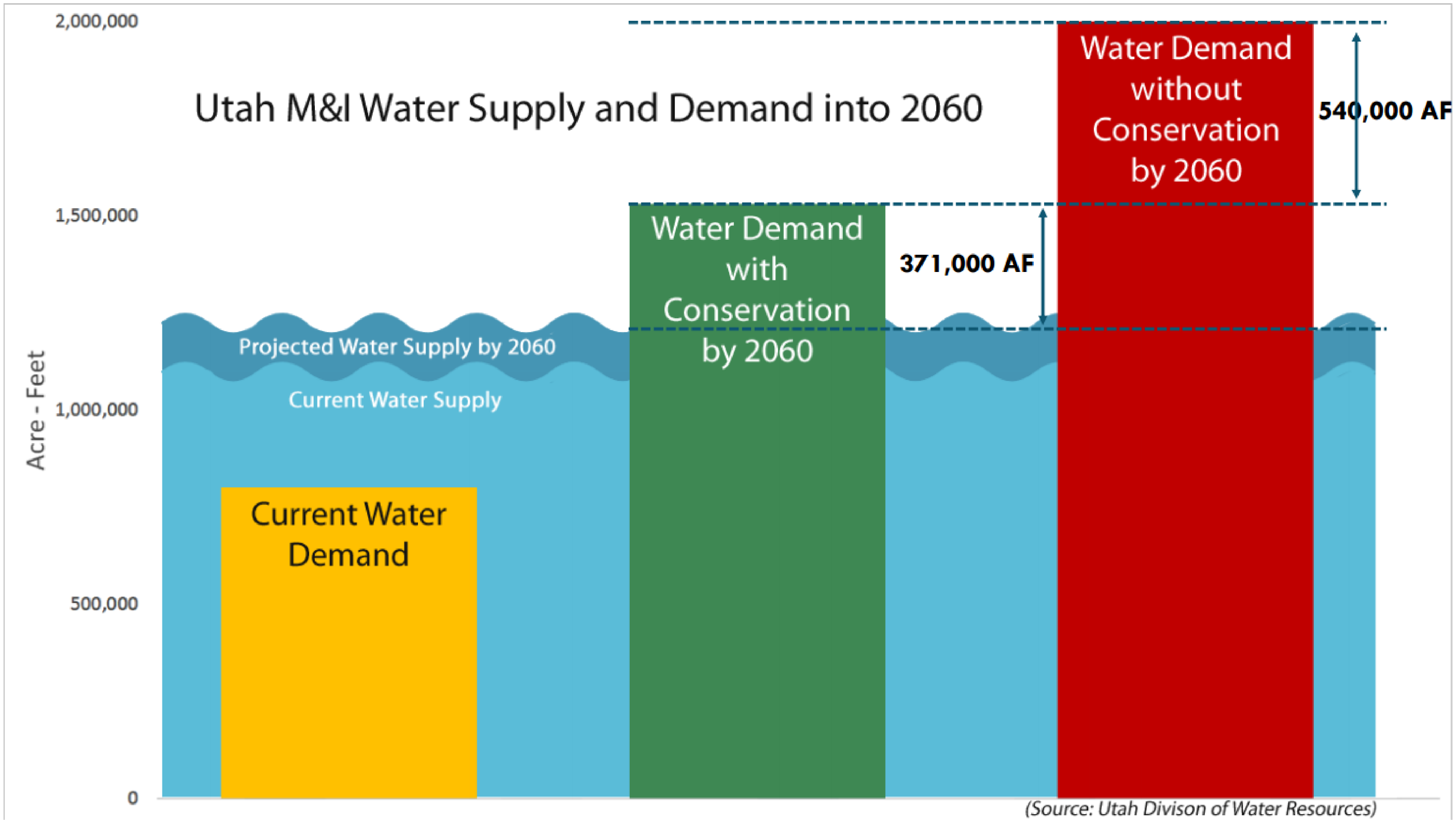
Water Conservation Incentives and Programs

David Rice
Conservation Programs Coordinator
Weber Basin Water Conservancy District

Why is water conservation important?



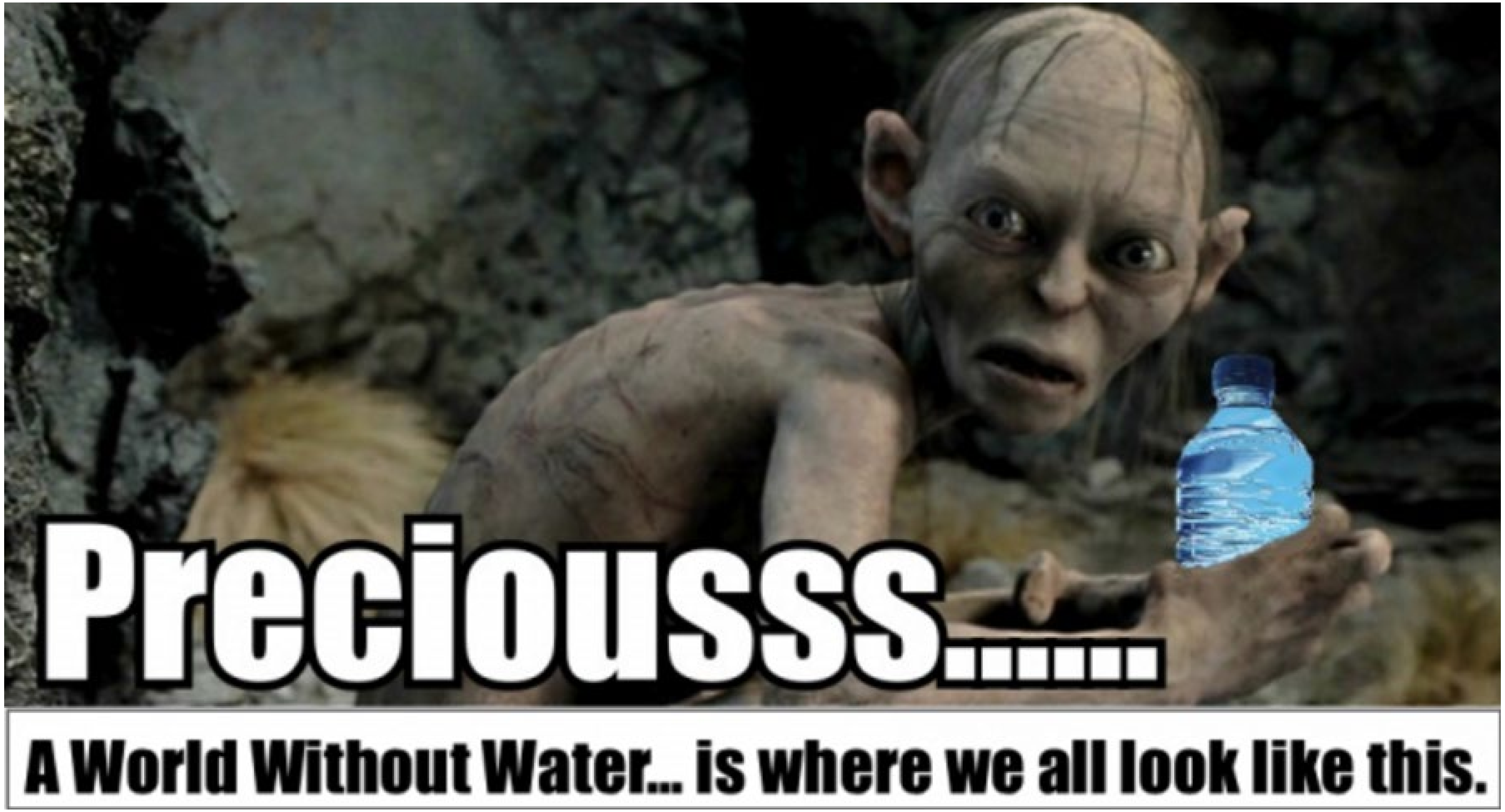
Why is water conservation important?



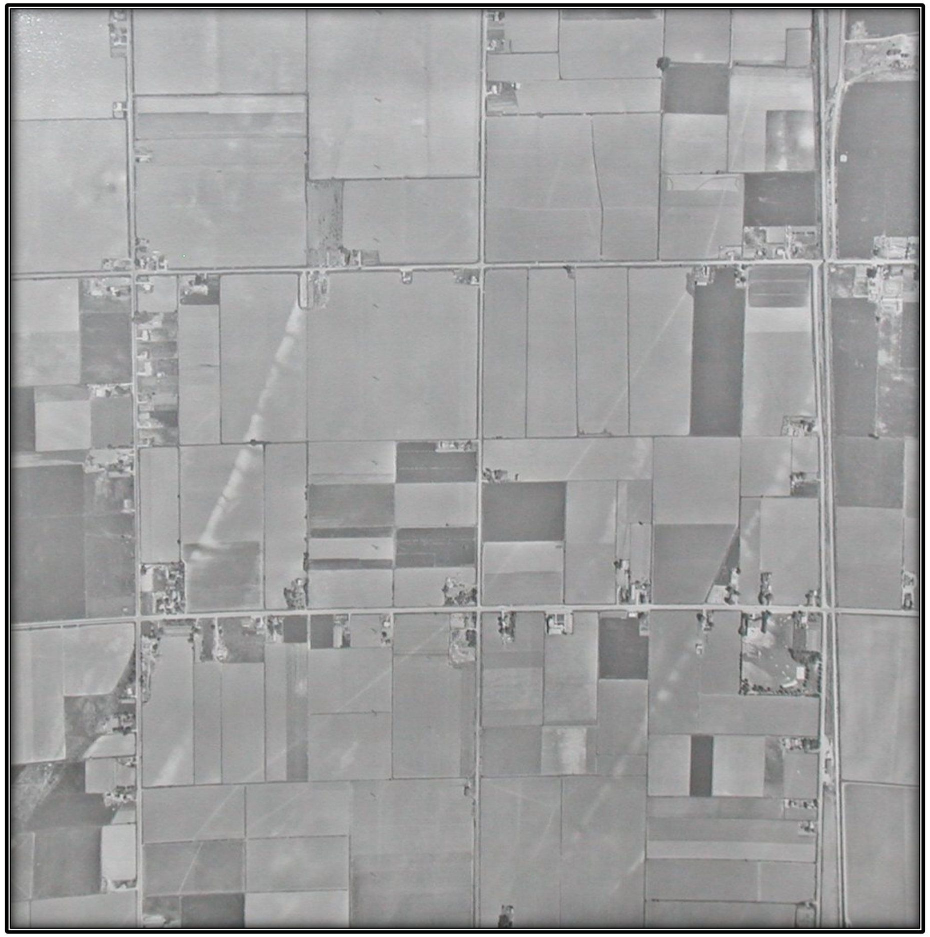
CONSERVATION GOAL

- 25% per capita reduction by 2025
- 35% per capita reduction by 2050

Conservation Inputs	% Reduction Required
Indoor Conservation	10.5%
Potable Outdoor Conservation	21.1%
Secondary Conservation	42.1%


Preciousss.......
A World Without Water... is where we all look like this.


CLINTON UTAH



1958

2019

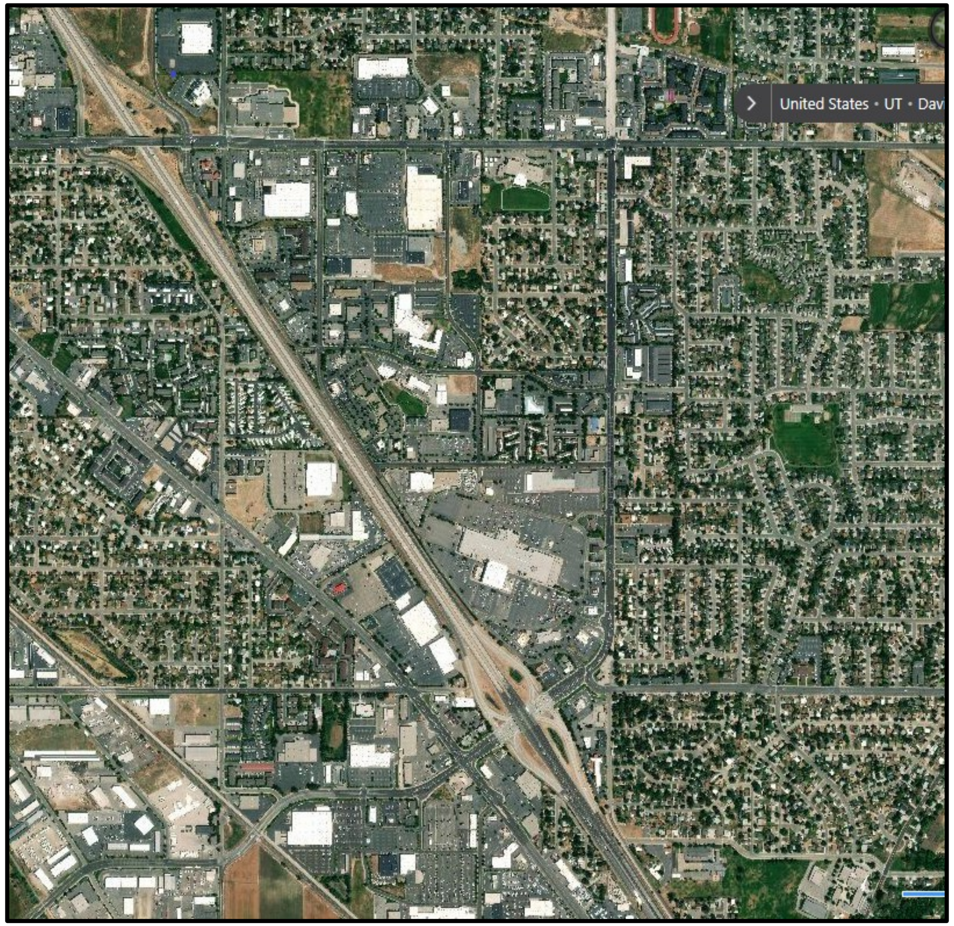
SYRACUSE UTAH

1958

2019

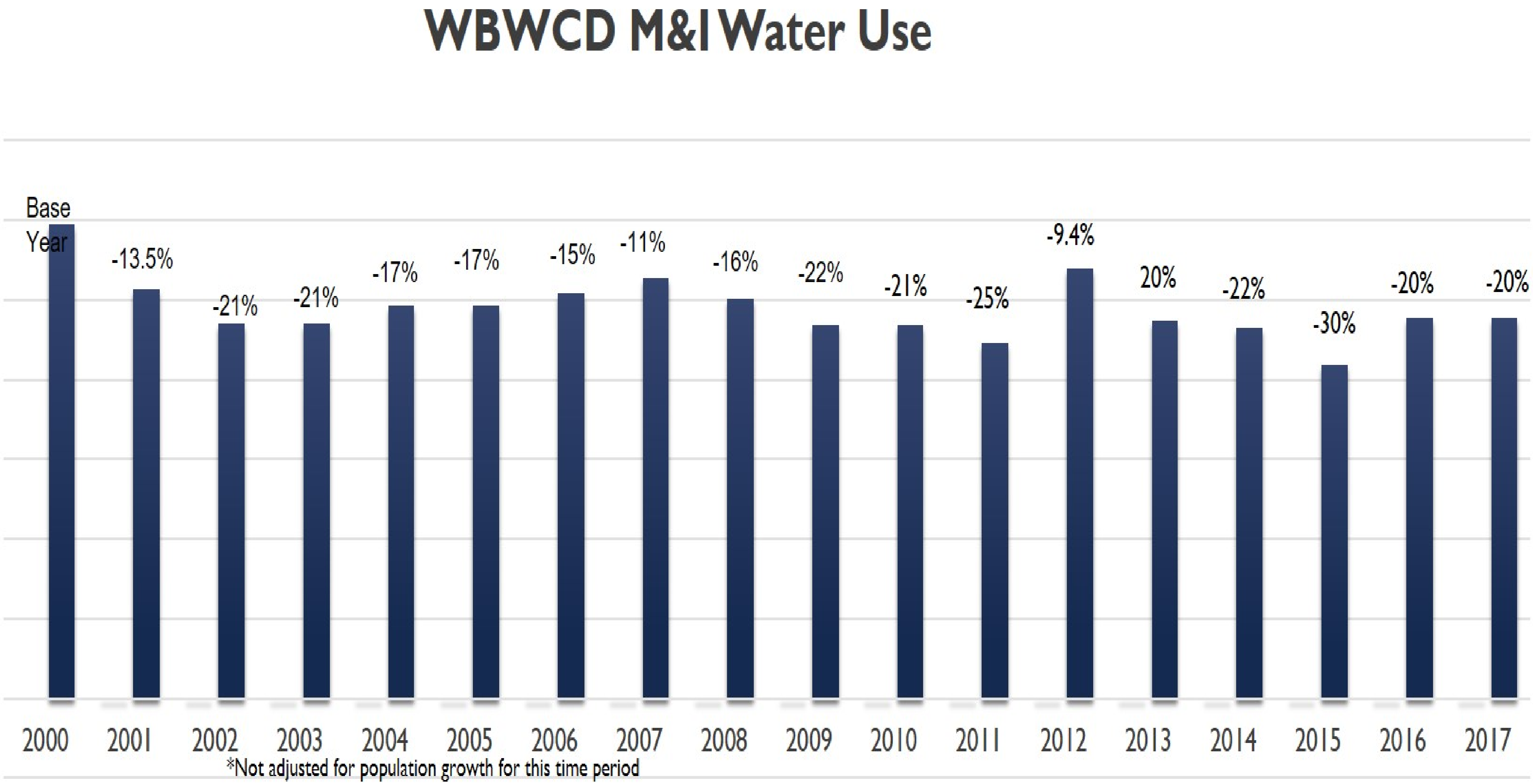
LAYTON UTAH

1958



2019

Conservation Progress Since 2000



Conservation Programs and Tools

- Public Education:
  - Water Checks, Website, Brochures, Free Classes, Free events, Advertisements, Time of day policy, water use reports
- Demonstration Gardens- demonstrations of low water landscaping and plant varieties. Located statewide
- Localscapes- Education and principles for landscaping in Utah
- Irrigation Smart Controller Rebates (offered statewide)
- Low Flow Toilet Rebates (offered statewide)
- Secondary Metering- meters being installed on all Weber Basin secondary connections
- City and Member Agency Involvement

Education

Because there's a lot of misconceptions out there

Garden Tours and Free Classes

The District provides an annual class series focusing on landscaping principles to result in healthy, more water efficient landscapes.
Groups and individuals can also have a tour of the garden to understand what the various displays mean and how to translate the information to their own yards.

Public Education: WTP Tours

"Davis Goes Green" Partnership to bring students in Davis School District for tours of the Water Treatment Plant and Learning Garden.

Garden Fairs

- KSL Greenhouse Show
- Activities and info for landscape water conservation
- Free hot dogs & sodas
- Local vendors and fun activities provided
- Estimated **1,200- 1,500** visitors for each fair.
- Increased participation each year.

Garden Programs: Localscapes

Localscapes

Landscape Spectrum

Traditional
Lawn-Dominant
Landscape

Yard typical to many Utahns

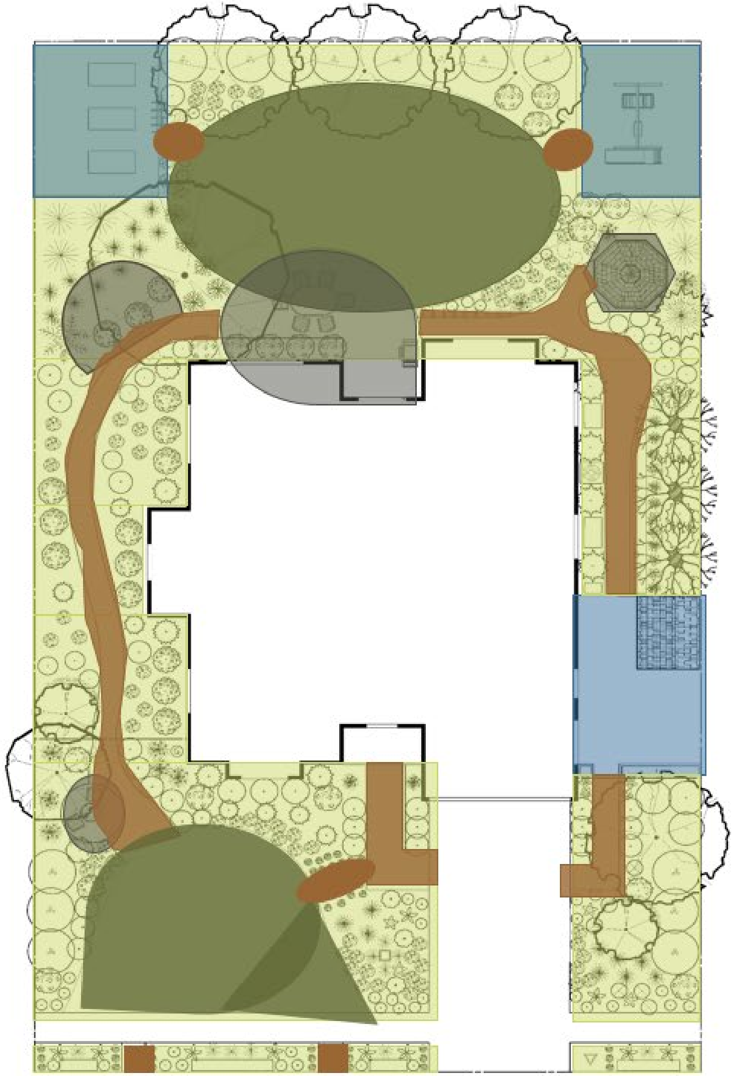
Localscapes Range

Moderate approach advocated by Localscapes

"Zeroscape"

Yard type many Utahns are **afraid** they'll be told to have

Garden Programs: Localscapes



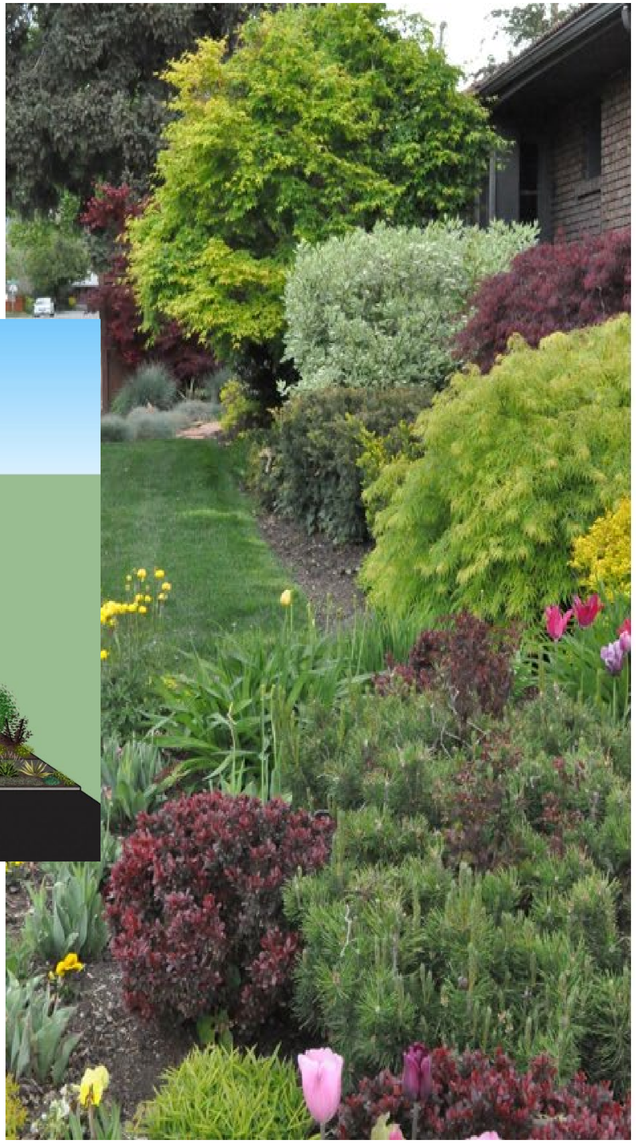
Localscapes

5- Steps of a Localscape

Localscape "Pattern Pieces"

1. Central Open Shape
2. Gathering Areas
3. Activity Zones
4. Paths
5. Plantings

Garden Programs: Localscapes



What is a "Localscape?"

Localscapes merges the advantages of lawn-based landscapes with xeriscape principles to define the "best way to landscape" within the environmental constraints of a given region.

Examples:

- Wasatch Front Localscape
- St. George Localscape
- Salt-Tolerant Localscape

Water Check Program

Education: Water Check Program

Catch Cup Test Worksheet

Name: Amy s — Address: 1018

Date: 6/2/15, 9:59 AM — Test Performed By: Tyler Michelle

Test 1: Zone 1,2 — Head Type: Rotor — Test 2: Zone 4 — Head Type: Spray

Test 1 Cup Depths

1.	.1	11.	.1	21.	
2.	.08	12.	.12	22.	
3.	.06	13.	.2	23.	
4.	.07	14.	.13	24.	
5.	.1	15.	.11	25.	
6.	.1	16.	.18	26.	
7.	.1	17.	.2	27.	
8.	.08	18.		28.	
9.	.16	19.		29.	
10.	.13	20.		30.	

Test 2 Cup Depths

1.	.04	11.	.07	21.	
2.	.06	12.	.06	22.	
3.	.06	13.	.06	23.	
4.	.06	14.		24.	
5.	.06	15.		25.	
6.	.04	16.		26.	
7.	.1	17.		27.	
8.	.07	18.		28.	
9.	.06	19.		29.	
10.	.07	20.		30.	

Test 1: Calculations

Precipitation Rate

0.119 (Cup Average) / 10:00 (Time ex. 5:30) X 60 = 0.714 (Precip Rate in/hr)

Distribution Uniformity

0.290 (Sum of Low Cups) / 4 (25% of Cups) = 0.073 (Low Average)

0.073 (Low Average) / 0.119 (Total Average) = 0.613 (Distribution Uniformity)

Test 2: Calculations

Precipitation Rate

0.062 (Cup Average) / 7:00 (Time ex. 5:30) X 60 = 0.531 (Precip Rate in/hr)

Distribution Uniformity

0.140 (Sum of Low Cups) / 3 (25% of Cups) = 0.047 (Low Average)

0.047 (Low Average) / 0.062 (Total Average) = 0.758 (Distribution Uniformity)

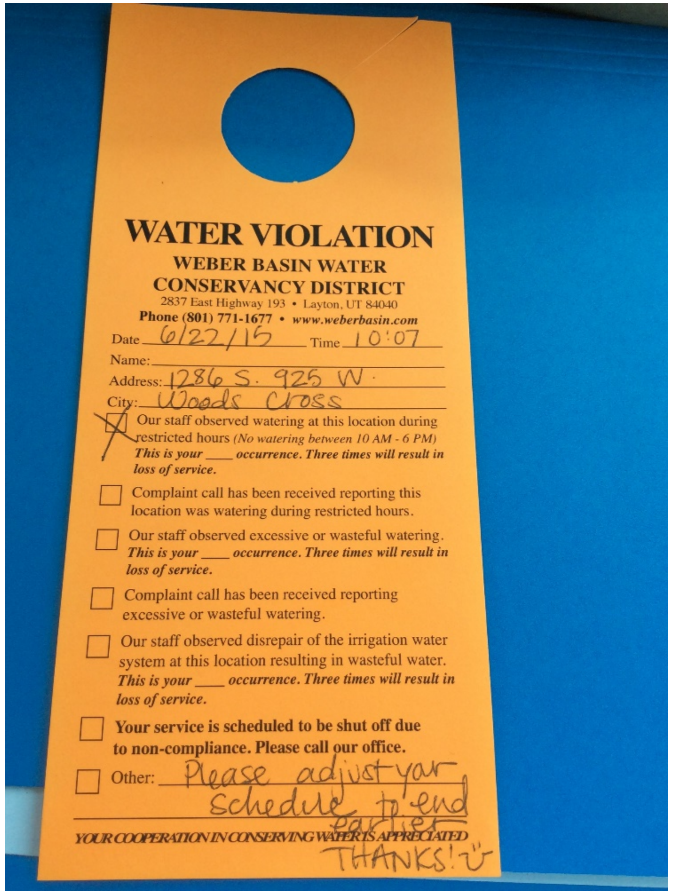
Calculate Test 1 — Clear All — Calculate Test 2

Capture Screenshot

Free service to evaluate the effectiveness of a homeowner's irrigation system. Testing the system uniformity, the rate of application, and pressure. Also leaving them tips for how to improves system performance and general landscape information.

*653 water checks done in 2016.

Time of Day Watering Policy



- No watering is allowed between 10:00 a.m. and 6:00 p.m.
- Violators receive a water violation notice along with educational materials


WHEN YOU SEE YOUR
NEIGHBOR WATERING
AFTER IT'S RAINED

Utahwatersavers.com

It Pays to Save

Ready to start saving water on your landscape or in your home? Create a Utah Water Savers account to view cash rebates and programs available in your area.

Programs and Rebates

Smart Controller Rebate Program

Receive 50% rebate up to $150 maximum for EPA WaterSense certified smart controllers that run on weather or soil moisture based operation.

Over 4000 rebates processes in 2018.

Examples

Rachio

Rain machine

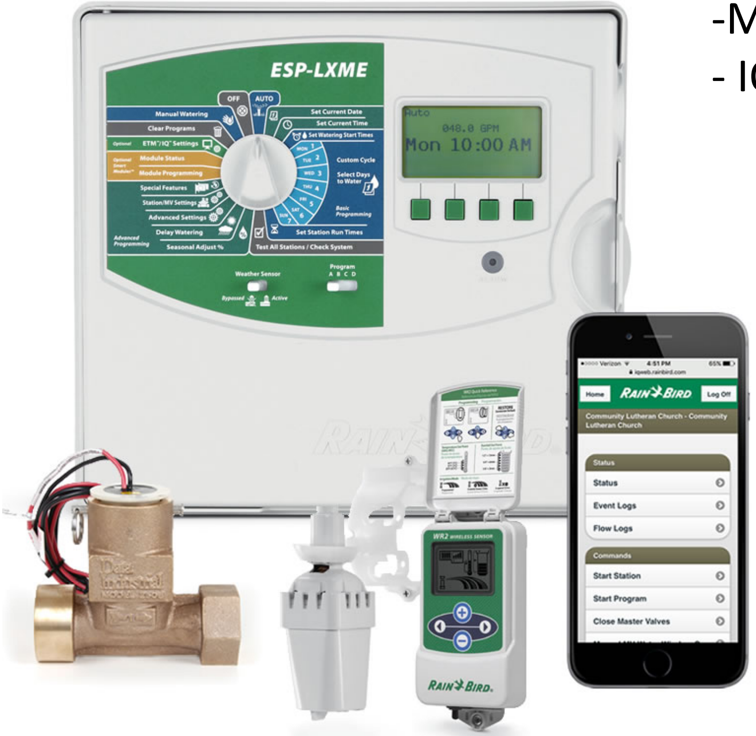
Orbit B-Hyve

Skydrop

Examples:

WeatherMatic

Rainbird: -Site Control
-Maxicom
- IQ



Toilet Rebate Program Statewide in 2019

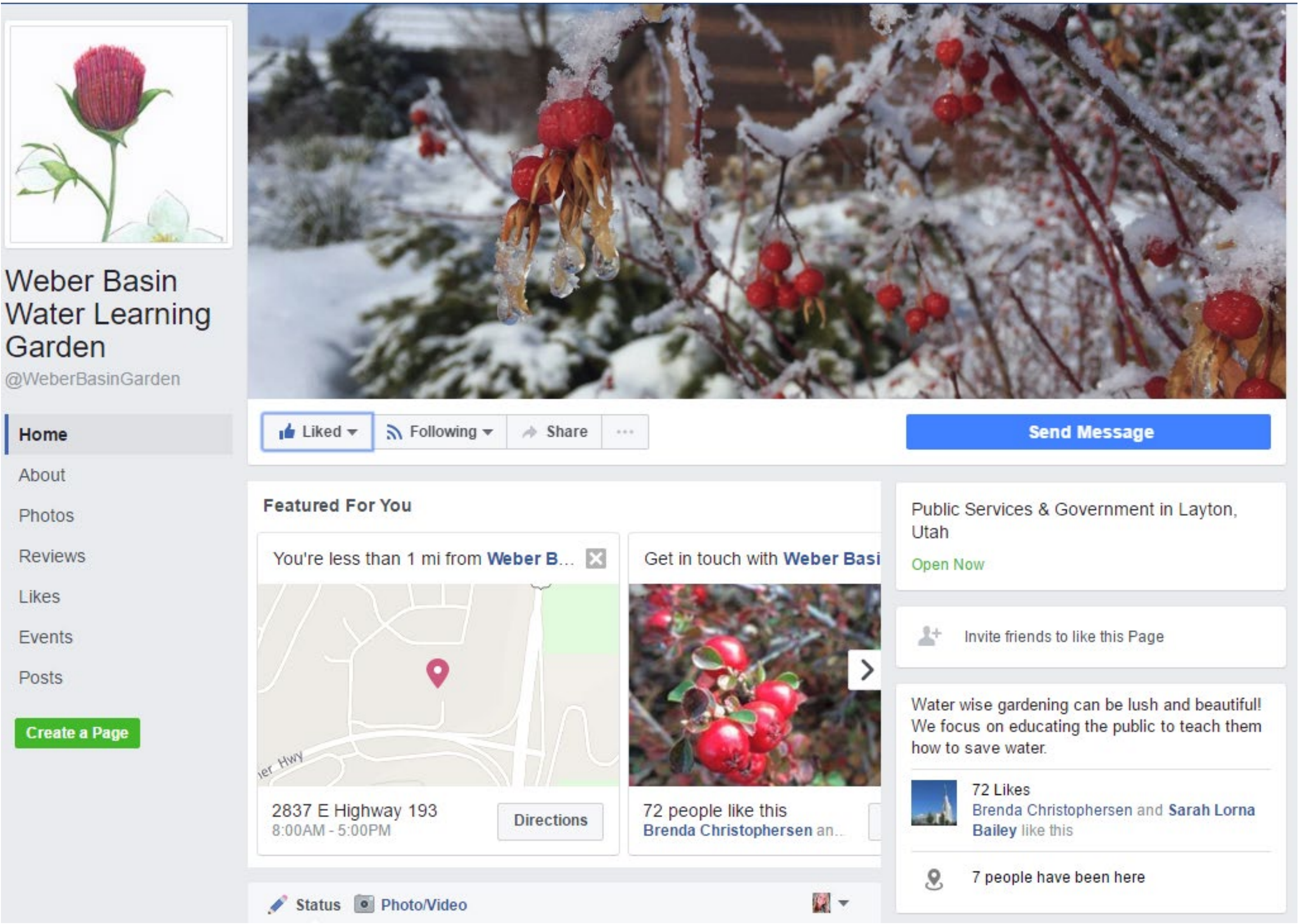
High Efficiency
1.0-1.28 GPF

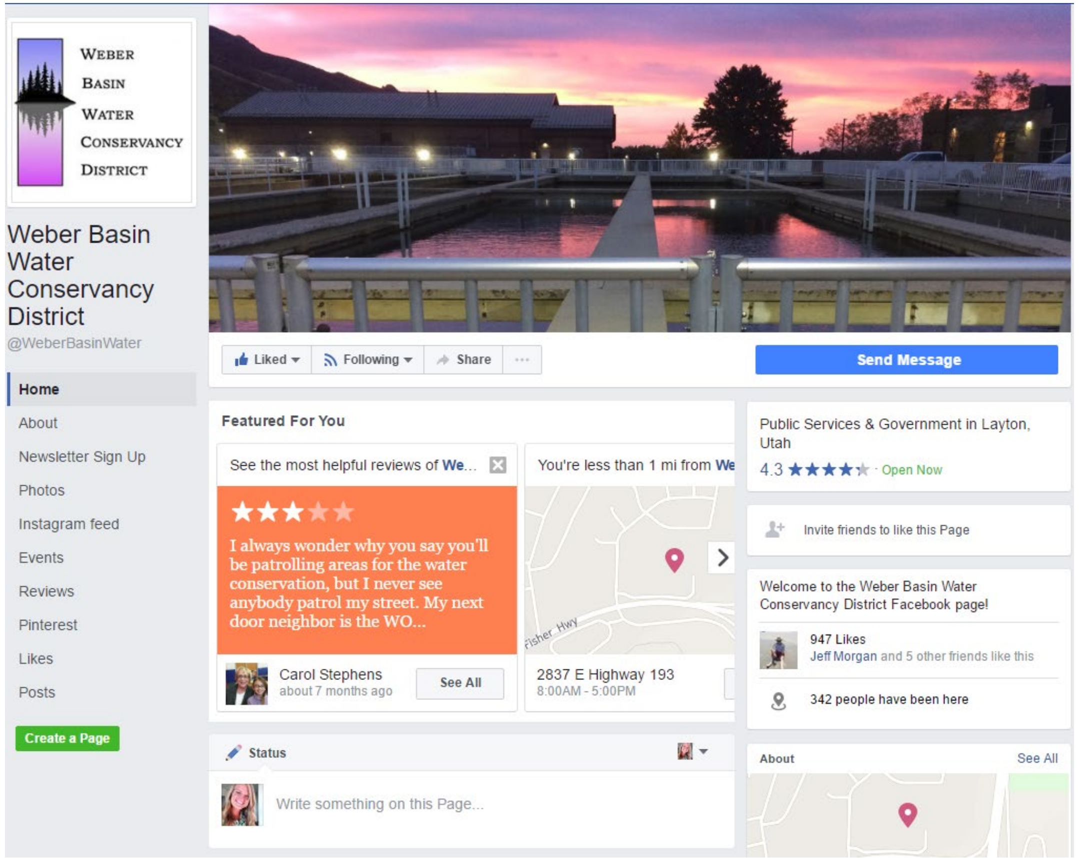
Low Flow 1.6-1.28 GPF

Dual Flush 1 GPF/1.28 GPF

Pressure Assist (tank view)

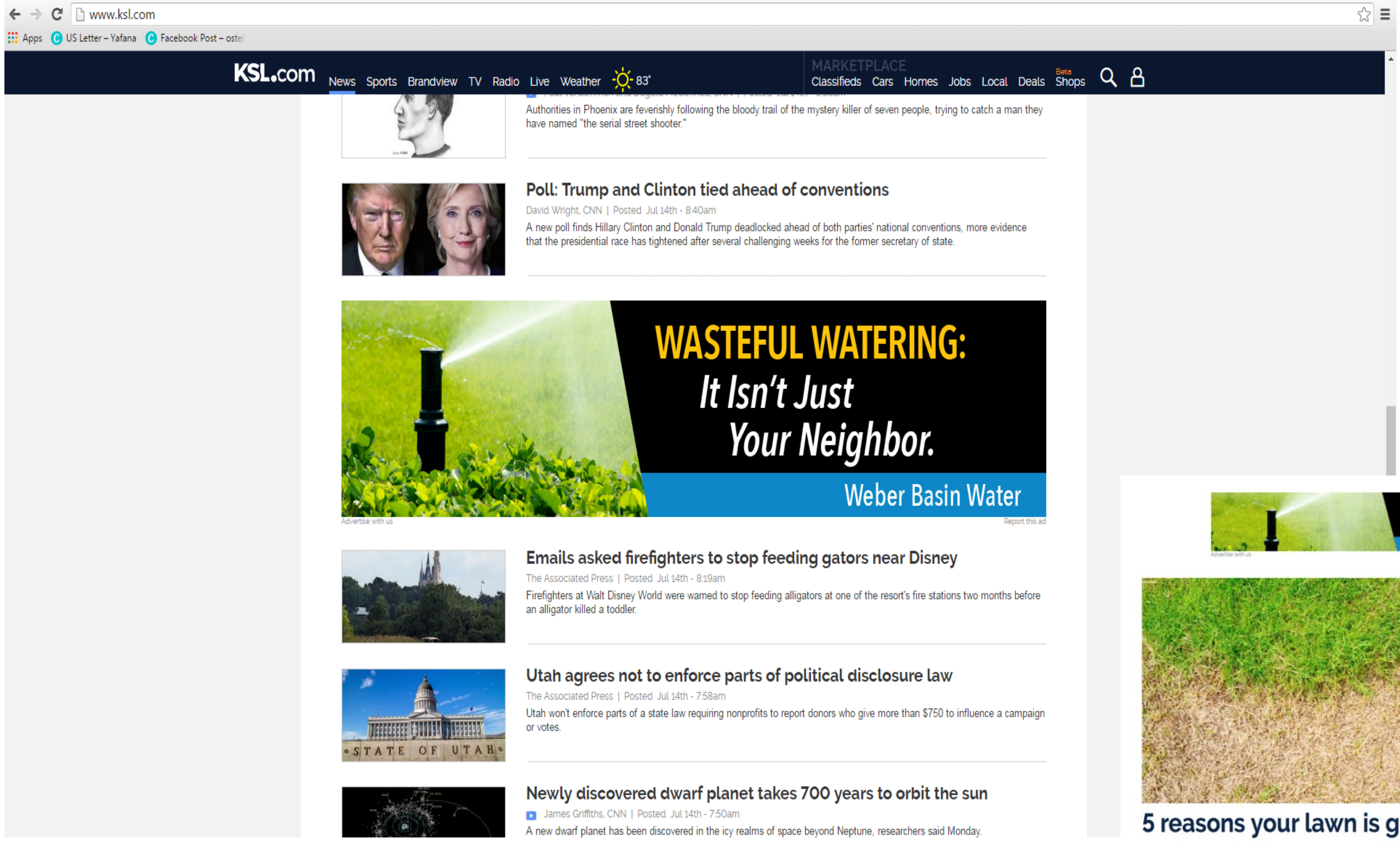
Public Education: Social Media



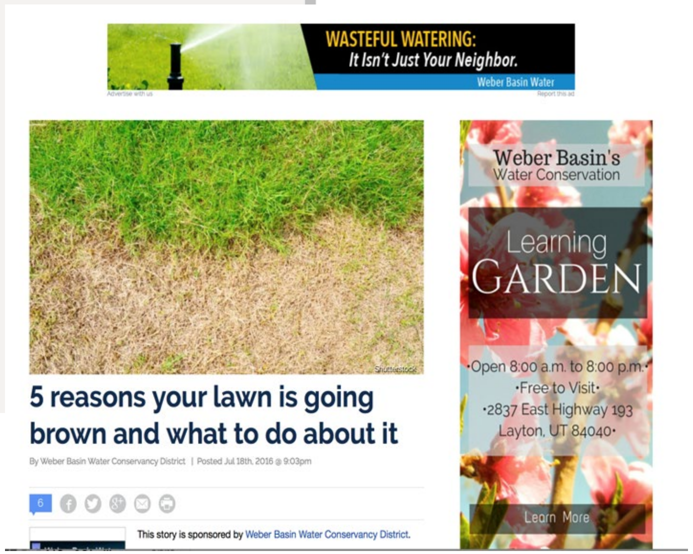


Posting information on Facebook, Instagram and Twitter to convey messages about water and water conservation principles.

Public Education: Digital Advertising

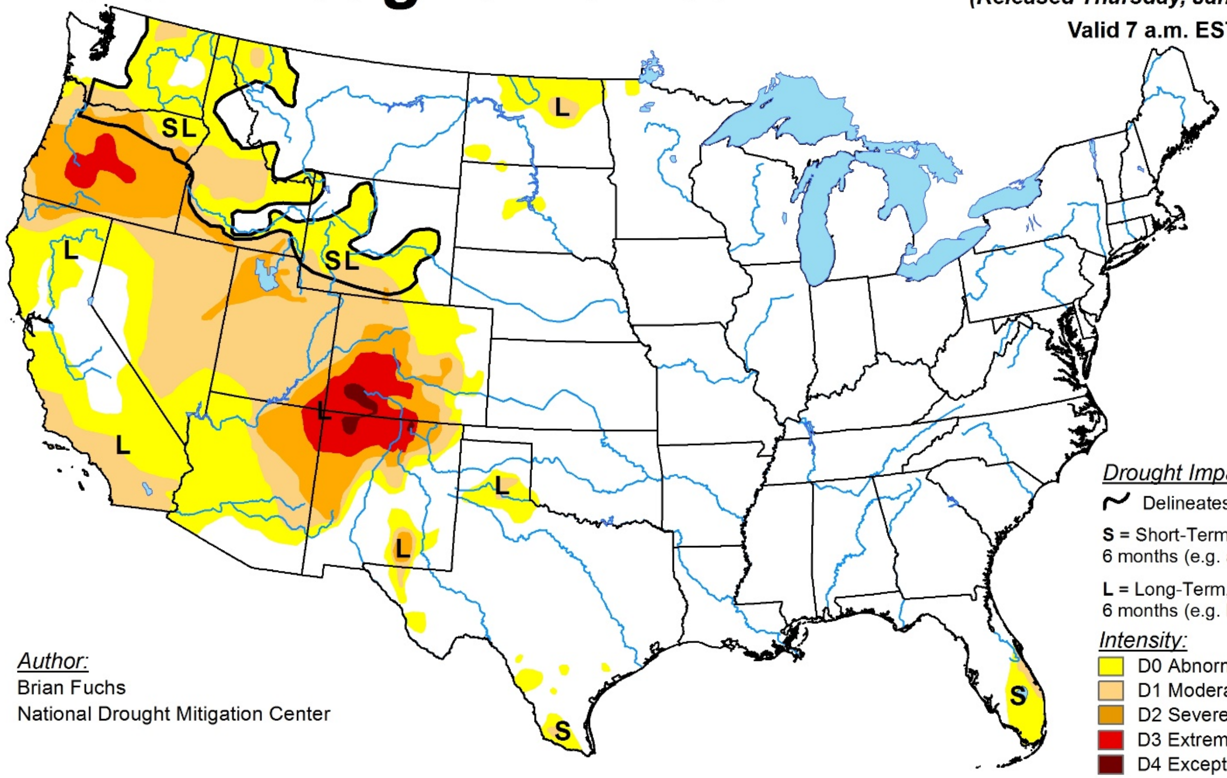


Provide sponsored content articles on KSL.com and StandardExaminer.com to promote outdoor conservation messages and invite good practices.



U.S. Drought Monitor

January 29, 2019
(Released Thursday, Jan. 31, 2019)
Valid 7 a.m. EST



Author:
Brian Fuchs
National Drought Mitigation Center

Drought Impact Types:

Delineates dominant impacts

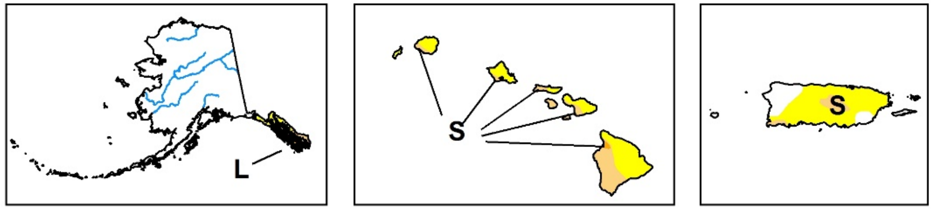
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

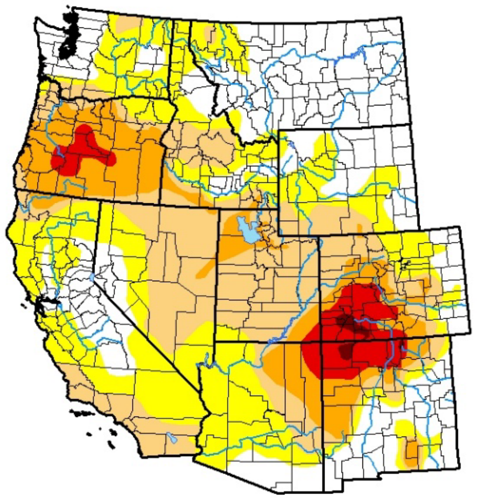
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



http://droughtmonitor.unl.edu/

U.S. Drought Monitor
West

January 29, 2019
(Released Thursday, Jan. 31, 2019)
Valid 7 a.m. EST



Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

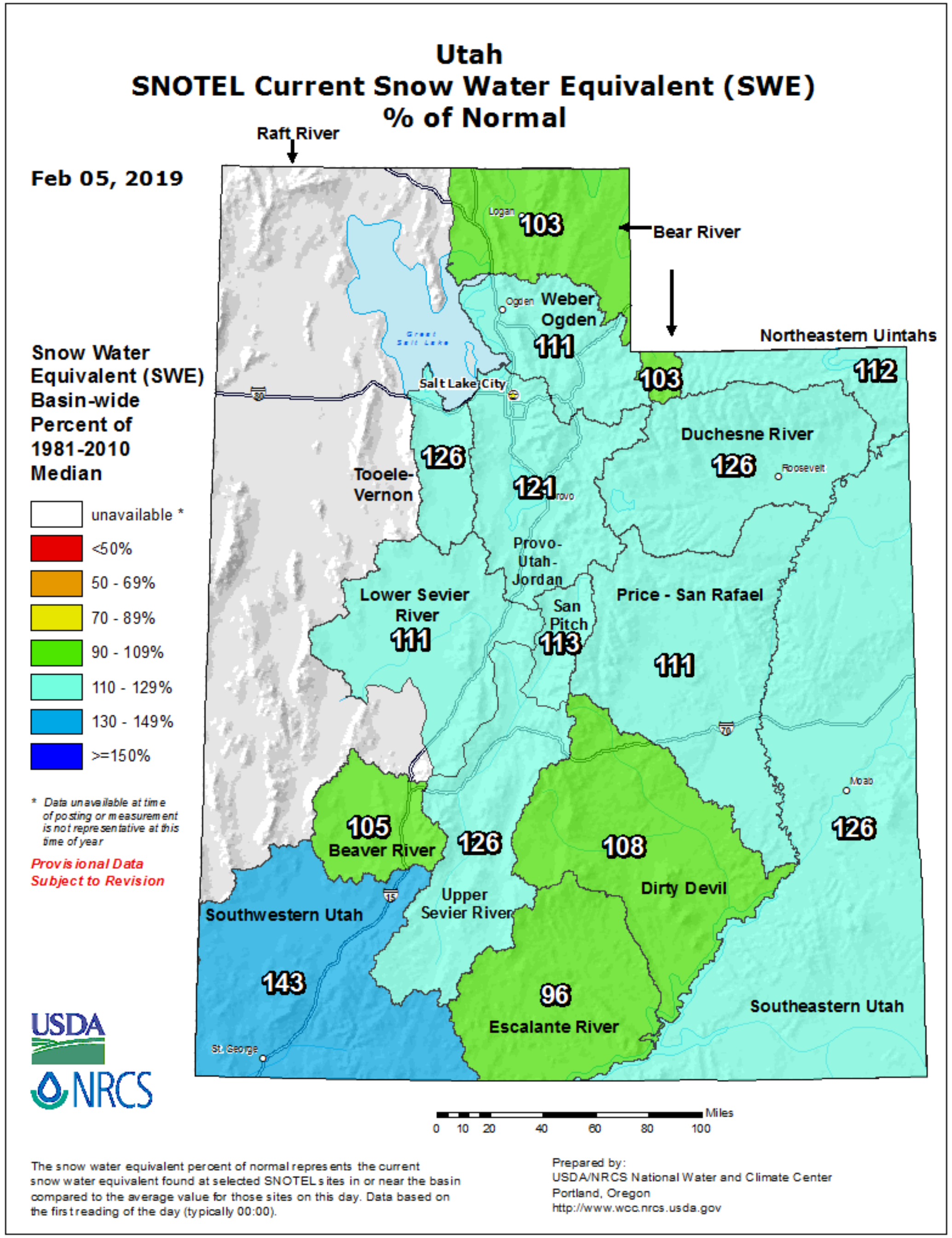
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Brian Fuchs
National Drought Mitigation Center

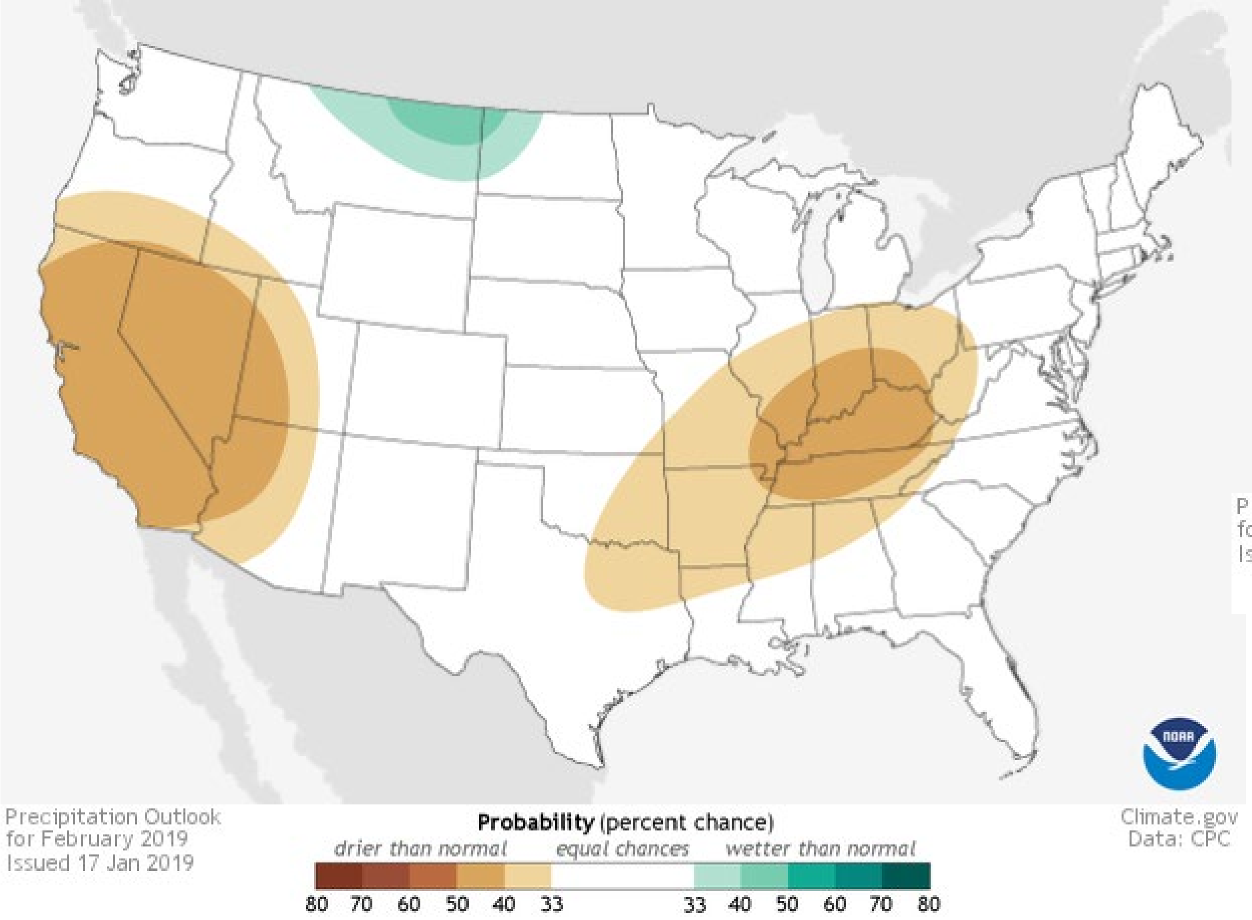
http://droughtmonitor.unl.edu/

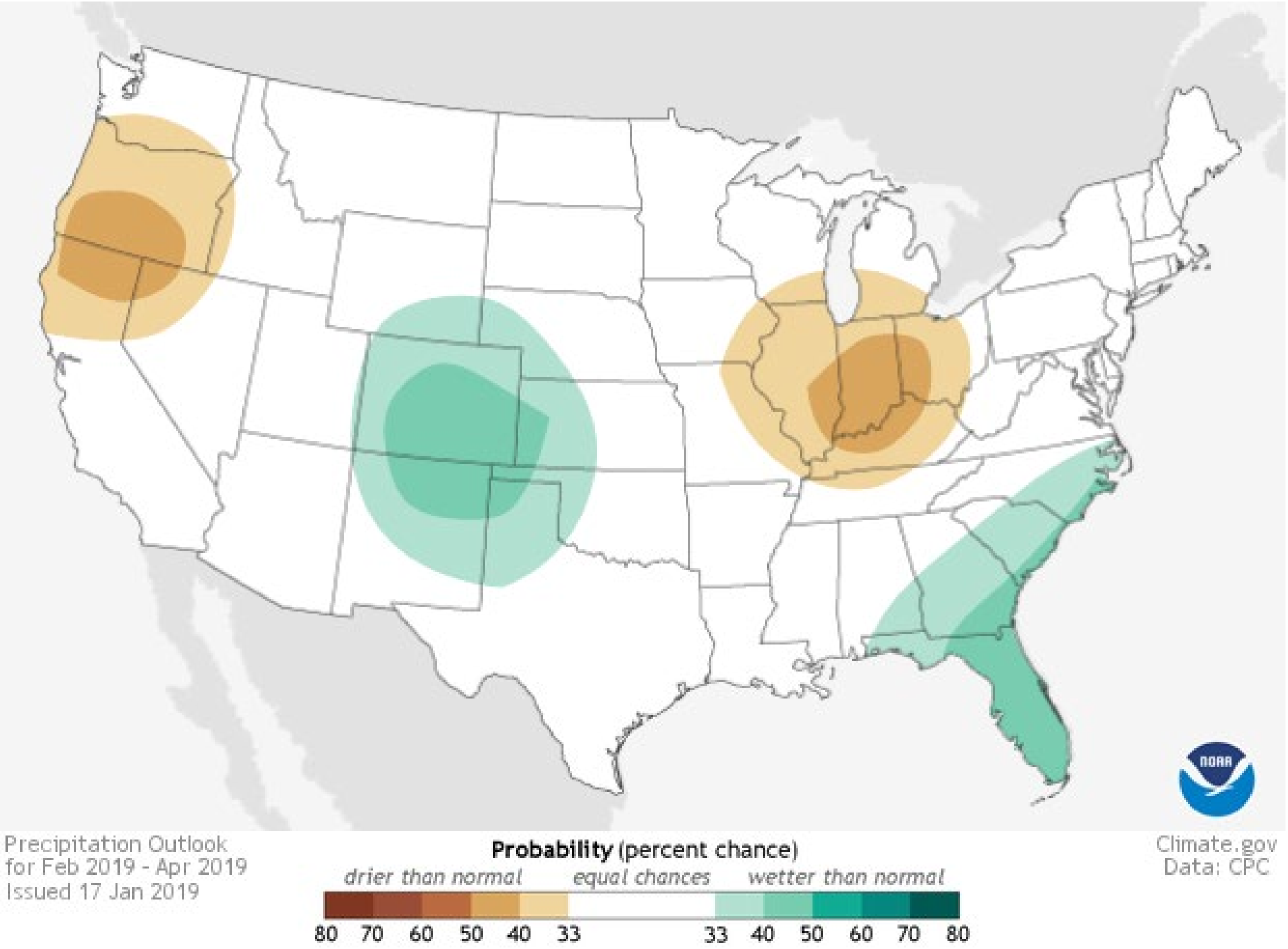
Water Supply and Forecasting

Year to year the snowpack is different and the resulting water supply is variable but the demand and growth continue at a rapid pace.



Precipitation Forecasting





Other Incentives Offered In Utah

- Park strip removal and replacement programs
- Landscape Consultation Programs
- Landscape Leadership Grants for businesses, institutions, developers, etc.
- City ordinances the encourage good landscape principles
- Conservation rate structures are becoming more common and incentivize lower use.

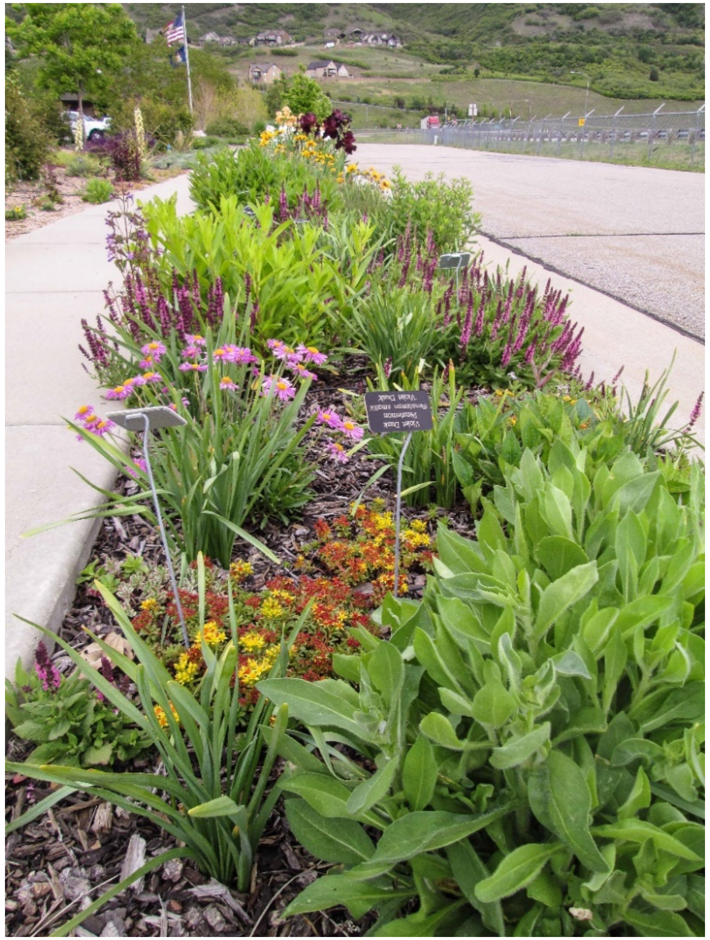
As water supplies continue to be strained, programs will evolve and increase in type of program and incentives being offered.

The Learning Garden: Purpose and Goals

- Show an example to the public about proper methods of landscaping in an arid climate.
- Displays of mature climate adapted and Utah-native plants.
- Engage in informal research and testing of low water landscape plants and irrigation methods and technologies.
- Educate the public through workshops, classes, events, publications.

Weber Basin's Water Conservation Learning Garden

The Learning Garden



Weber Basin's
Water Conservation
Learning Garden

Weber Basin's
Water Conservation
Learning Garden

Weber Basin's
Water Conservation
Learning Garden

Weber Basin's
Water Conservation
Learning Garden

Back to Top

Water Outlook, Conservation, and Trends

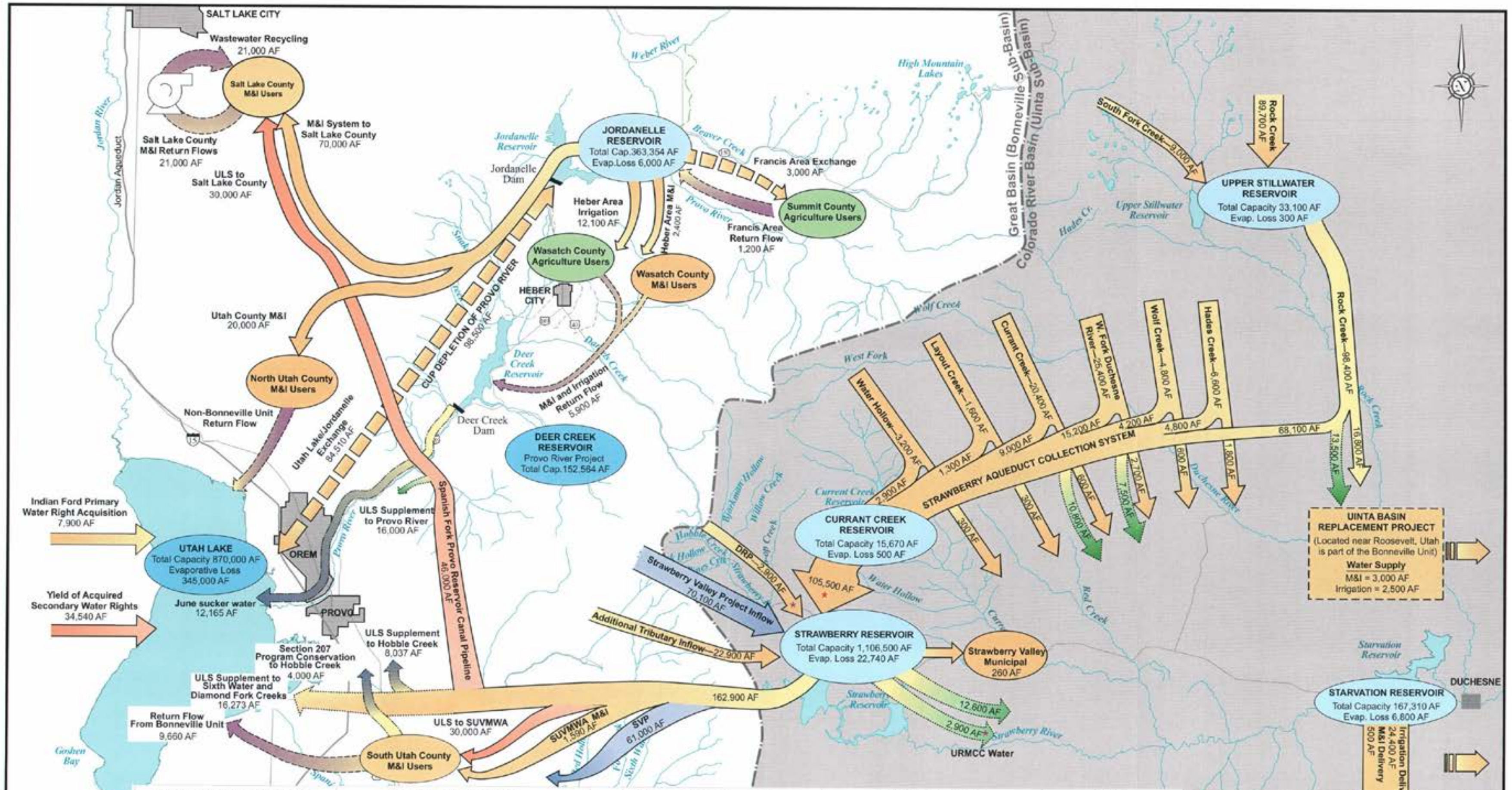
A quick look at the current water projections for the State and how it impacts all users and agriculture. Conservation needs to help address the future of water supply shortages and how conservation will play a part. Some current trends in conservation that could impact the agriculture community.

Rick Maloy
Water Conservation Manager
Central Utah Water Conservancy District
rick@cuwcd.com

"Rick Maloy is the Water Conservation Manager at Central Utah Water Conservancy District who works with State and local water agencies to develop water conservation strategies and public outreach tools. Rick knows the importance of water and what needs to be done to meet the future demand as the state of Utah continues to grow, particularly regarding outdoor water use. Rick has spent over a decade working in the field of water distribution and conservation and serves as the current president of the Utah Water Conservation Forum a non-profit group devoted to supporting professionals in sustaining a statewide water conservation movement.
Rick holds a bachelor's degree from the University of Utah and a master's degree from Utah State University. "

CENTRAL UTAH WATER
CONSERVANCY DISTRICT

Water Outlook, Conservation, and Current Trends



Depletions to the Provo River

Description of Depletion	Average Annual Acre-Feet
M&I Salt Lake County	70,000
M&I North Utah County	20,000
Francis Area Agriculture	3,000
Wasatch County Agriculture	9,200
Daniels Replacement Project	2,900
M&I Wasatch County	2,400
Jordanelle Evaporation & Storage	6,000
Francis Area Return	-1,200
Wasatch County Agric. Return	-4,400
Wasatch County M&I Return	-1,500
Indian Ford/ Utah Lake Rights	-7,900
Total	**98,500**

Depletions to Utah Lake

Description of Depletion	Average Annual Acre-Feet
Provo River Depletion	98,500
Strawberry to Supplement Sixth Water and Diamond Fork	-16,273
Strawberry to Supplement Hobble Creek	-8,037
Strawberry to Supplement Provo River	-16,000
North Utah County M&I Return	
So Utah Return	-9,660
Yield of Utah Lake Rights	-34,540
Total	**13,990**

Depletions to the Colorado River

Description of Depletion	Average Annual Acre-Feet
Strawberry Collection System Operation	
Bonneville Unit water released to the Basin	-101,900
Strawberry Valley M&I use	-260
Strawberry Reservoir evaporation (BU portion)	-17,700
Upper Stillwater Reservoir evaporation	-300
Current Creek Reservoir evaporation	-500
Starvation Collection System Operation	
Duchesne River area Irrigation	-12,200
Duchesne River area M&I use	-250
Starvation Reservoir evaporation	-6,800
Uinta Basin Replacement Project	
Roosevelt area M&I use	-1,500
Upalco area irrigation use	-1,250
Offsetting gain from Daniel Replacement Project	+2,900
Total	**139,760**

Strawberry Reservoir

Project	Inflow	Outflow to Great Basin
Strawberry Valley Project	70,100 AF	61,000 AF
Central Utah Project	128,400 AF	101,900 AF
Daniel Replacement Project	2,900 AF	0 AF
Total	**201,400 AF**	**162,900 AF**

Project	Outflow to Uinta Basin
Strawberry Valley M&I	260 AF
Instream Flow	12,600 AF
Daniel Replacement Project	2,900 AF
Total	**15,760 AF**

Notes:

BONNEVILLE UNIT

CUP Transbasin diversion 101,900 AF

AF = acre-feet

Water deliveries and spills

Fishery flows

Return flows

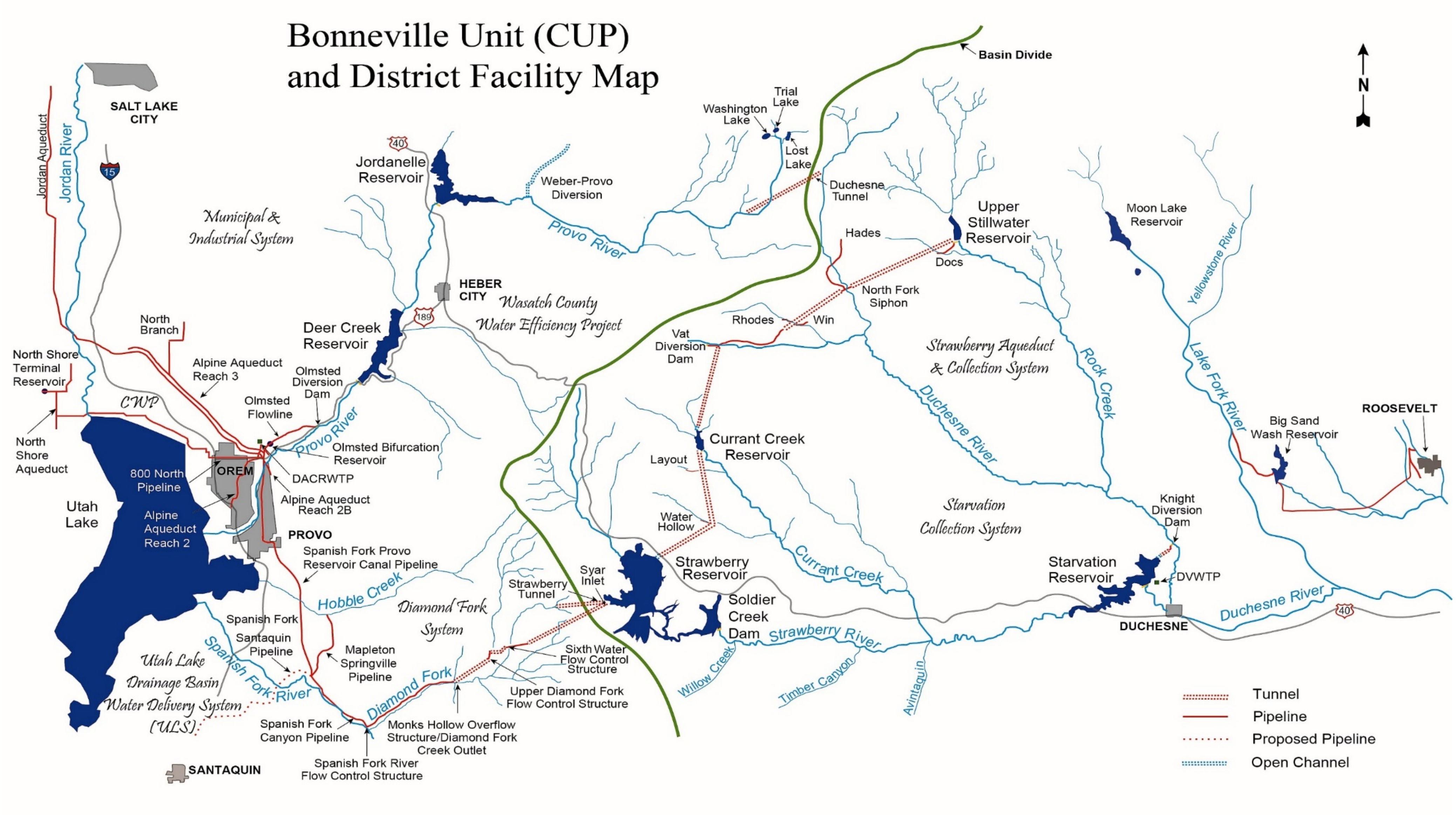
June sucker flow

* Includes 4,000 AF Strawberry Valley Project Water

* Wasatch County Water Efficiency Project and Daniel Replacement Project

Sum of fishery flow in Uinta Basin = 44,400 AF

Figure 3-1
Distribution of Bonneville Unit Water


Bonneville Unit (CUP)
and District Facility Map
Basin Divide
N
SALT LAKE CITY
Jordan Aqueduct
Jordan River
15
40
Jordanelle Reservoir
Weber-Provo Diversion
Provo River
Washington Lake
Trial Lake
Lost Lake
Duchesne Tunnel
Upper Stillwater Reservoir
Moon Lake Reservoir
Hades
Docs
Municipal & Industrial System
HEBER CITY
189
Wasatch County Water Efficiency Project
North Fork Siphon
Rhodes
Win
Vat Diversion Dam
Yellowstone River
Strawberry Aqueduct & Collection System
Rock Creek
Lake Fork River
North Branch
North Shore Terminal Reservoir
Alpine Aqueduct Reach 3
Deer Creek Reservoir
Olmsted Diversion Dam
Olmsted Flowline
CWP
North Shore Aqueduct
Olmsted Bifurcation Reservoir
OREM
DACRWTP
800 North Pipeline
Alpine Aqueduct Reach 2B
Utah Lake
Alpine Aqueduct Reach 2
PROVO
Spanish Fork Provo Reservoir Canal Pipeline
Duchesne River
Currant Creek Reservoir
Layout
Water Hollow
ROOSEVELT
Big Sand Wash Reservoir
Starvation Collection System
Knight Diversion Dam
Hobble Creek
Diamond Fork System
Strawberry Tunnel
Syar Inlet
Strawberry Reservoir
Currant Creek
Starvation Reservoir
DVWTP
Spanish Fork
Santaquin Pipeline
Utah Lake Drainage Basin Water Delivery System (ULS)
Spanish Fork River
Mapleton Springville Pipeline
Diamond Fork
Sixth Water Flow Control Structure
Upper Diamond Fork Flow Control Structure
Soldier Creek Dam
Strawberry River
Willow Creek
Timber Canyon
Avintaquin
DUCHESNE
Duchesne River
Spanish Fork Canyon Pipeline
Monks Hollow Overflow Structure/Diamond Fork Creek Outlet
Spanish Fork River Flow Control Structure
SANTAQUIN
Tunnel
Pipeline
Proposed Pipeline
Open Channel

Growth in Utah

"Utah's population is projected to increase from approximately 3 million in 2015 to 5.8 million in 2065."

Research Brief
July 2017

Kem C. Gardner
POLICY INSTITUTE
THE UNIVERSITY OF UTAH

Utah's Long-Term Demographic and Economic Projections Summary

Principal Researchers: Pamela S. Perlich, Mike Hollingshaus, Emily R. Harris, Juliette Tennert & Michael T. Hogue

Background

The Kem C. Gardner Policy Institute prepares long-term demographic and economic projections to support informed decision making in the state. The Utah Legislature funds this research, which is done in collaboration with the Governor's Office of Management and Budget, the Office of the Legislative Fiscal Analyst, the Utah Association of Governments, and other research entities. These 50-year projections indicate continued population growth and illuminate a range of future dynamics and structural shifts for Utah. An initial set of products is available online at gardner.utah.edu. Additional research briefs, fact sheets, web-enabled visualizations, and other products will be produced in the coming year.

State-Level Results

Population

- Utah's population is projected to increase from approximately 3 million in 2015 to 5.8 million in 2065. This represents an increase of 2.8 million people with an annual average rate of change of 1.3 percent.
- The Utah population reached 3 million in 2015. Utah is projected to reach 4 million in 2032 (17 years after 2015), 5 million in 2050 (18 years after 2032), and 5.8 million in 2065.
- Though growth rates are projected to decelerate over the next 50 years, they are also projected to exceed national growth rates. Utah's growth in each decade ranges from 9.7 percent (2050-2060) to 16.7 percent growth (2010-2020). The national range is 4.4 percent (2050-2060) to 7.5 percent (2010-2020).

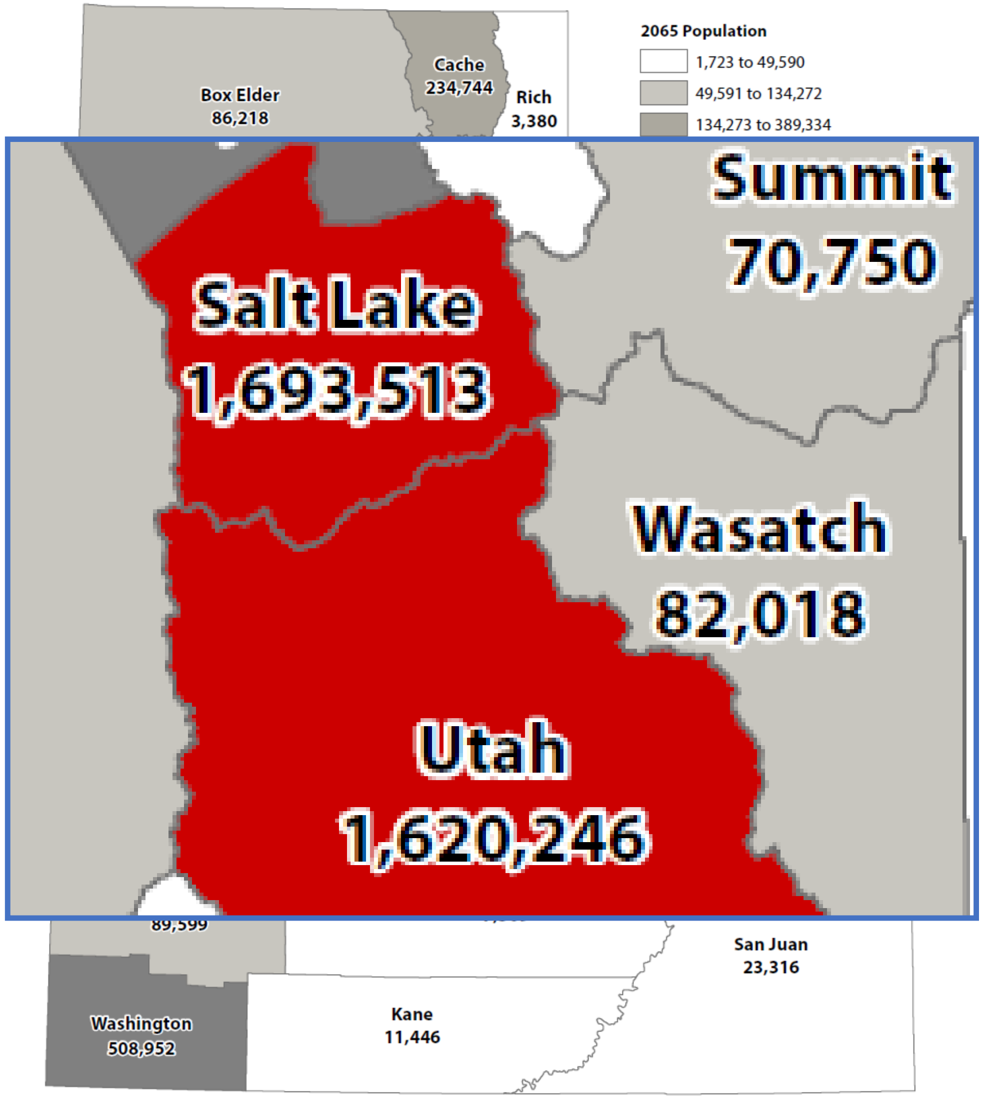
Components of Population Change

- Utah's total fertility rate (average number of children born to a Utah woman in her lifetime) is projected to continue the existing trend of a slow decline. From 2015-2065, rates are projected to decline from 2.32 to 2.29. These rates are projected to remain higher than national rates that move from 1.87 to 1.86 over a similar period.
- In 2065, life expectancy in Utah is projected to be 86.3 for women and 85.2 for men. This is an increase of approximately 4 years for women and 6 years for men. The sharper increase for men narrows the life expectancy gap traditionally seen between the sexes.
- Natural increase (births minus deaths) is projected to remain positive and account for two-thirds of the cumulative population increase to 2065. However, given increased life expectancy and declining fertility, the rate and amount of natural increase are projected to slowly decline over time.
- Net migration accounts for one-third of the cumulative population increase to 2065. Projections show the contributions of natural increase and net migration converging over time.

Age Composition

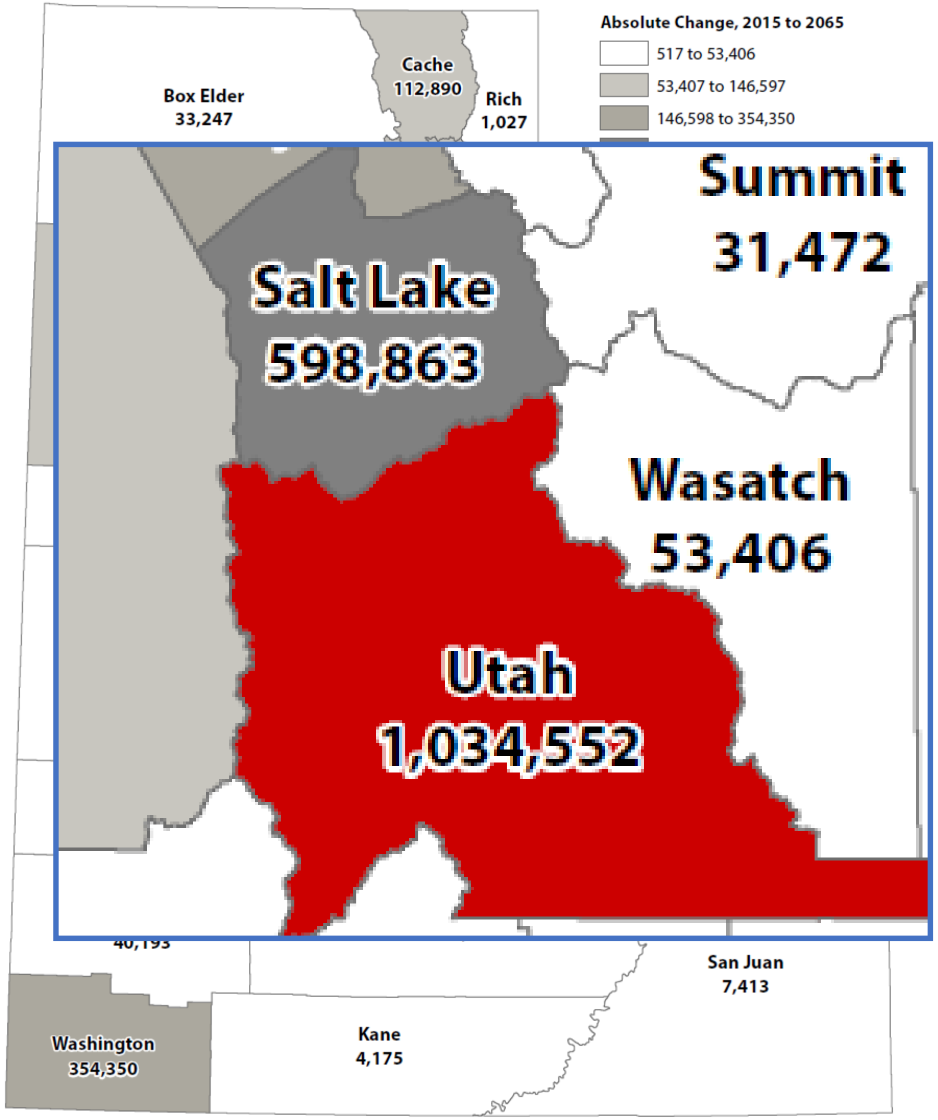
- Utah's median age is projected to increase by seven and a half years, rising from 30.7 years in 2015 to 38.3 years in 2065. This is a result of declining fertility and increasing life expectancy, which contribute to a larger share of retirement age persons in the population.
- The share of the population ages 65 and older is projected to double over the next 50 years, rising from 10.2 percent of the population in 2015 to 20.3 percent in 2065.
- In 2015, Utah had 372 centenarians (people at least 100 years old). That number is projected to be nearly 20 times greater by 2065, reaching 6,846 centenarians.

Figure 1:
Utah Population by County
2065



Source: Kem C. Gardner Policy Institute 2015-2065 State and County Projections.

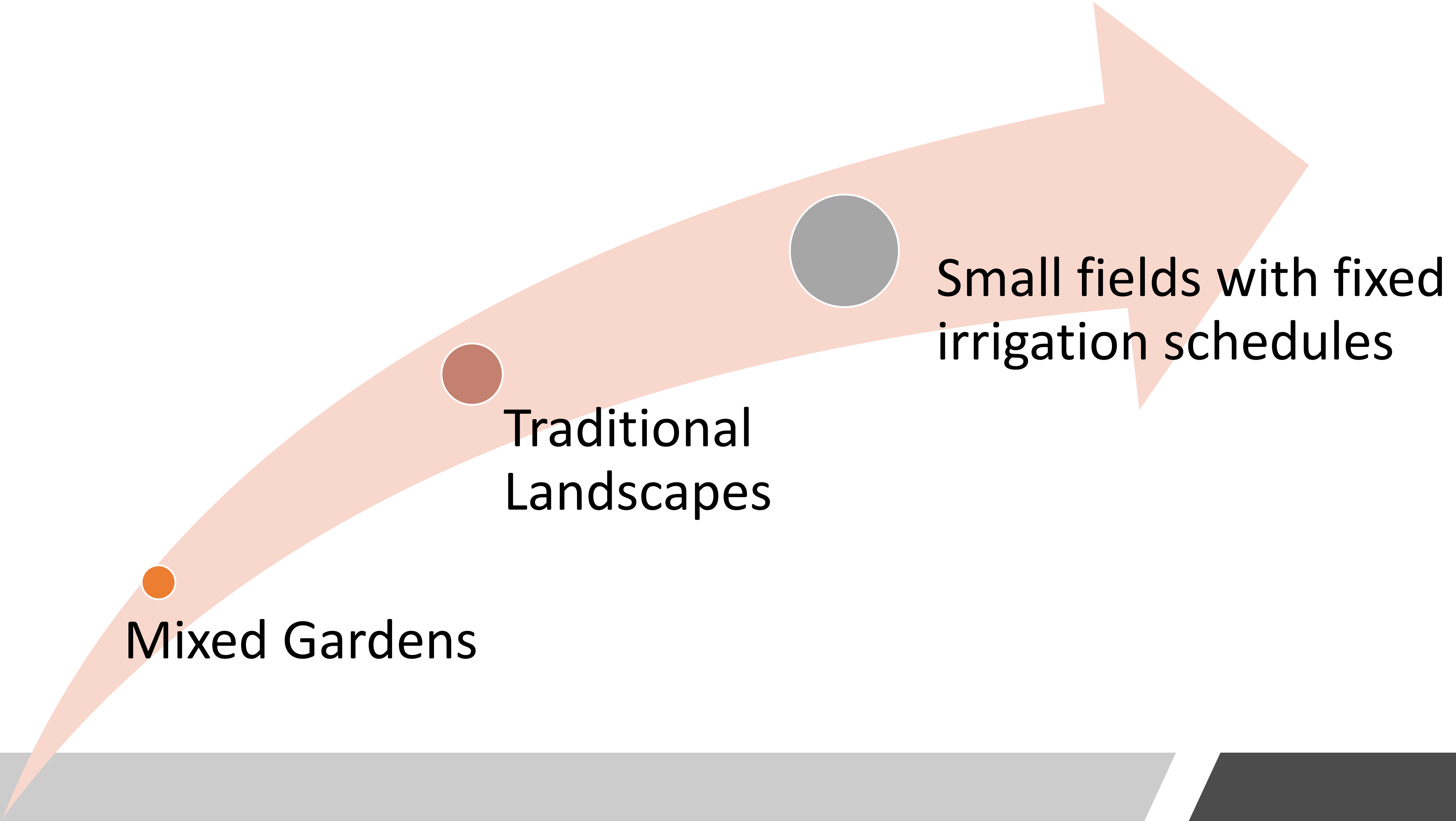
Figure 2:
Absolute Change in Utah Population by County
2015-2065



Sources: Kem C. Gardner Policy Institute 2015-2065 State and County Projections; DemographyUTAH Population Committee 2010-2016 Population Estimates.

“There’s been a 245% increase in the number of farms of 1-9 acres along the Wasatch Front since 1974”

Tyler Pratt with Keller Associates

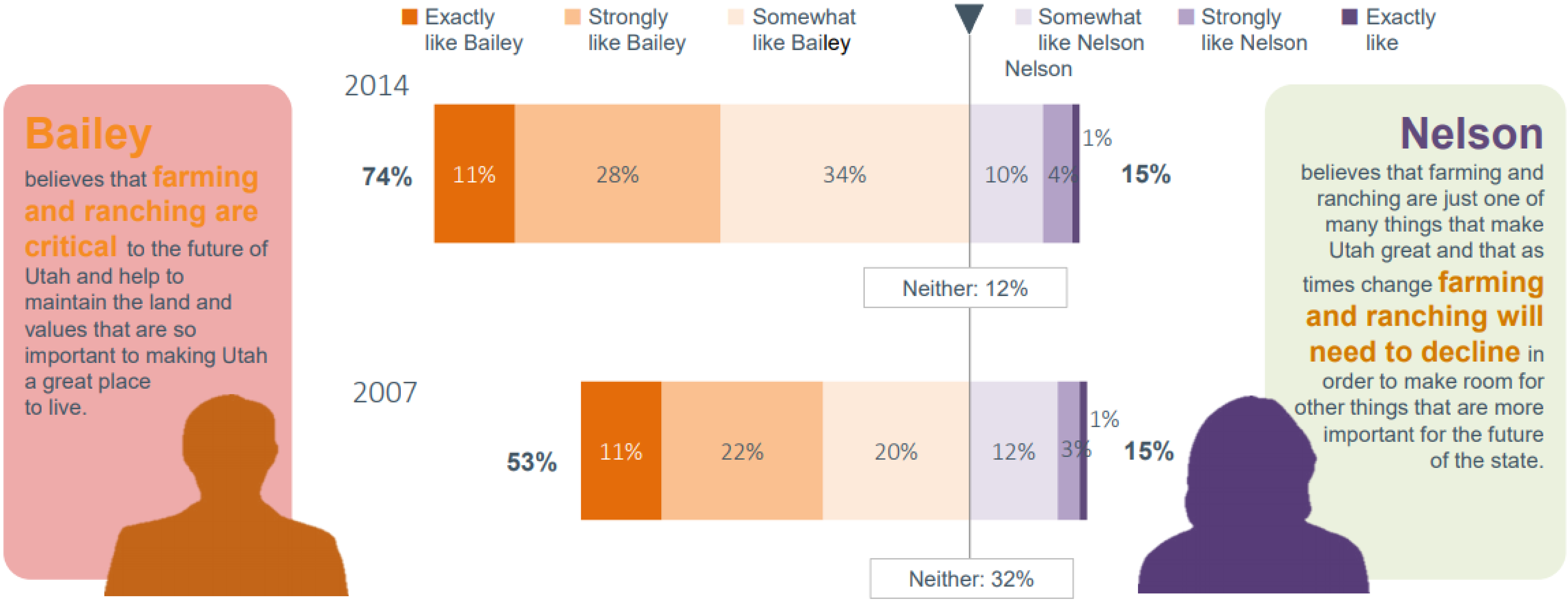

Small fields with fixed irrigation schedules
Traditional Landscapes
Mixed Gardens


Envision Utah

How we grow matters.

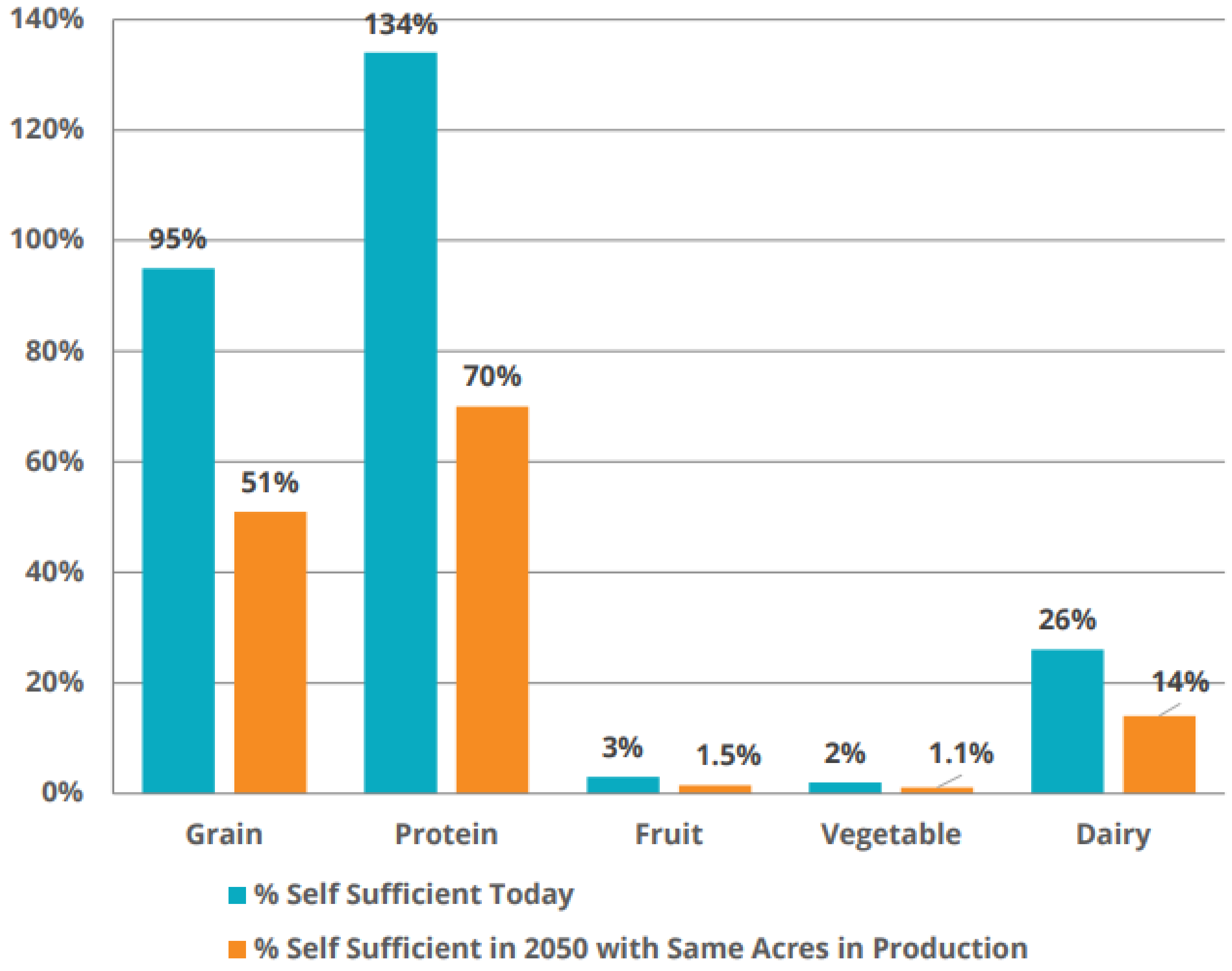
Agriculture Values

In 2007, almost a third of Utahns did not have a strong opinion about farming and ranching. However, by 2014, 74% agree that it is critical to Utah's future.



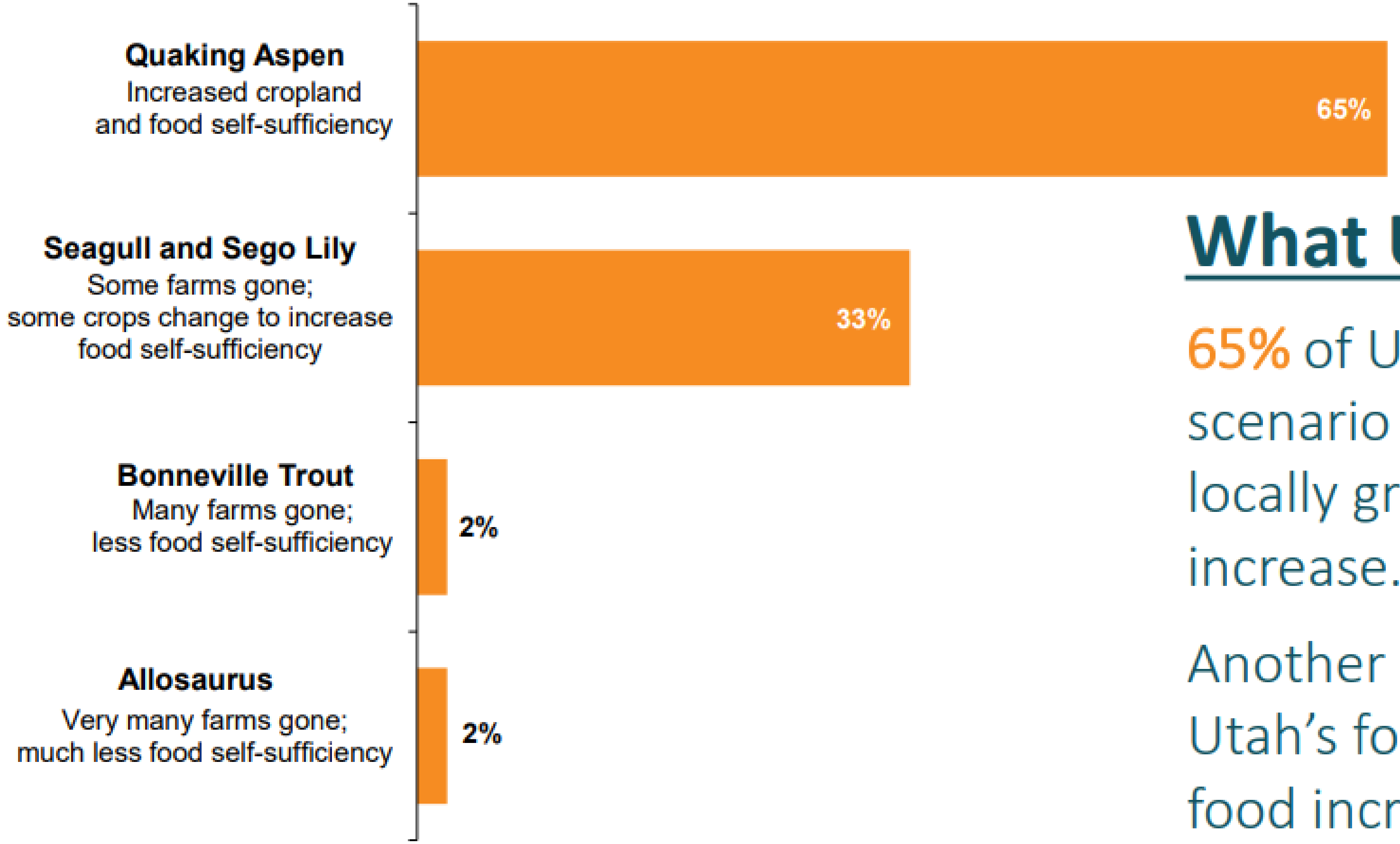
BASE: ALL QUALIFIED RESPONDENTS (N=1000)
Q720. Below are the opinions of two hypothetical Utah residents. Please indicate which opinion comes closest to your own. Is your opinion more like Mr. Bailey or more like Mr. Nelson?

Utah's Agriculture Today



- We produce only 3% of our fruit and 2% of our vegetables
- By 2050 we will cut our per person production in half by population growth alone
- If we continue to urbanize prime agriculture land/take water from farmland we will produce almost no fruits and vegetables in Utah, and very little dairy

Issue-specific Scenarios
% "Favorite" Selections, n=19,389



Source: Website – Select your favorite agriculture outcome(s) from the 4 presented below for Utah in 2050. Consider our self sufficiency from local agriculture.

OUTREACH
n = 52,845

What Utahns Want:

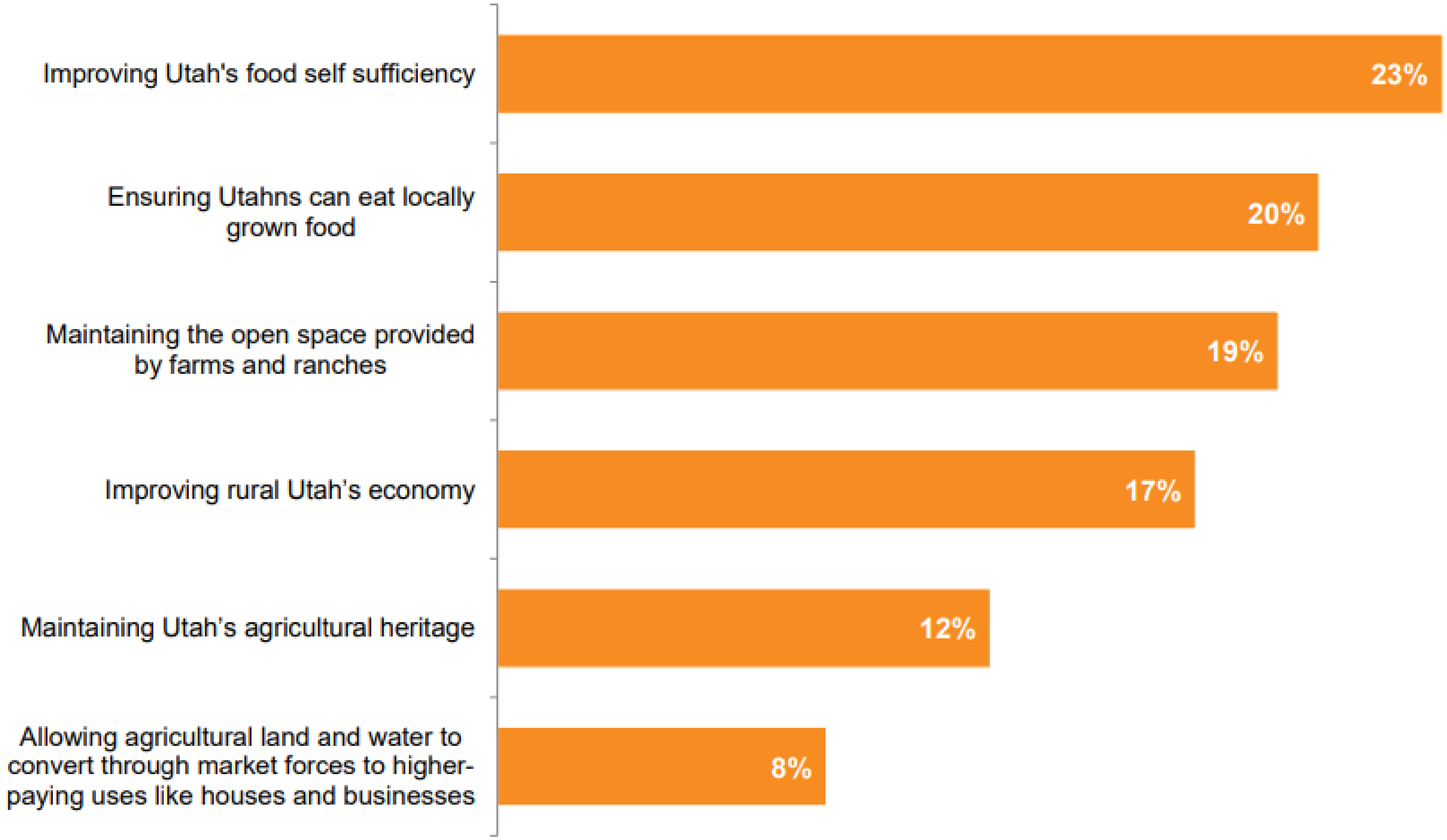
65% of Utahns selected an agriculture scenario in which Utah's food self-sufficiency, locally grown food, and cropland significantly increase.

Another 33% chose a scenario in which Utah's food self-sufficiency and locally grown food increase, but to a somewhat lesser extent.

Only 4% want food production to continue to decline.

Importance of Outcomes

Average % Allocated, n=4,875



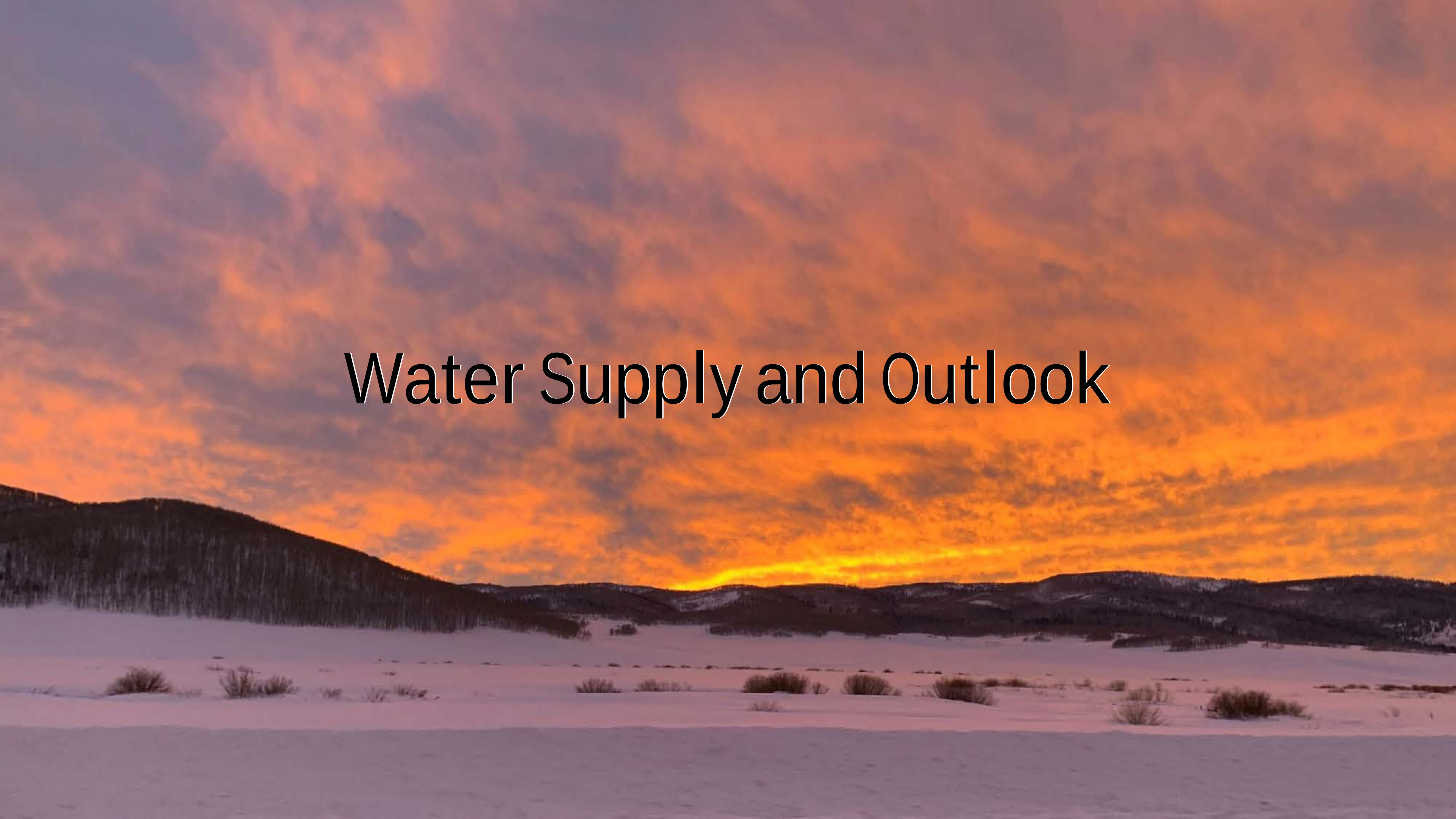
Why Utahns Want to Improve Agriculture:

Utahns want the state be more self sufficient in supplying its own food, as well as have high-quality locally grown food for themselves and their families.

Source: Website – Please indicate each outcome's relative importance by allocating 100 points across all outcomes. The more points you allocate to a given outcome, the more important it is to you to achieve that outcome.

OUTREACH
n = 52,845

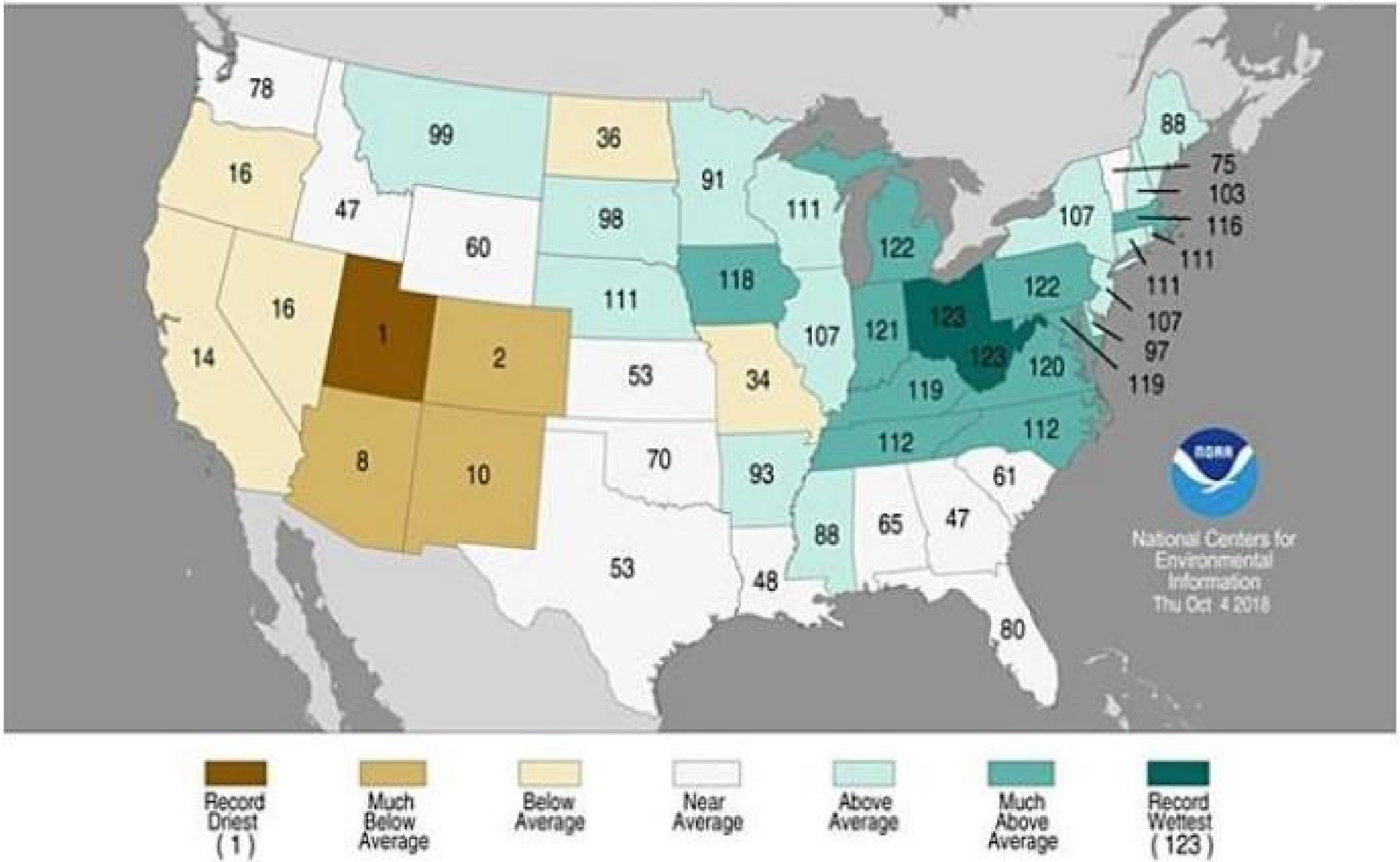
Water Supply and Outlook



Statewide Precipitation Ranks

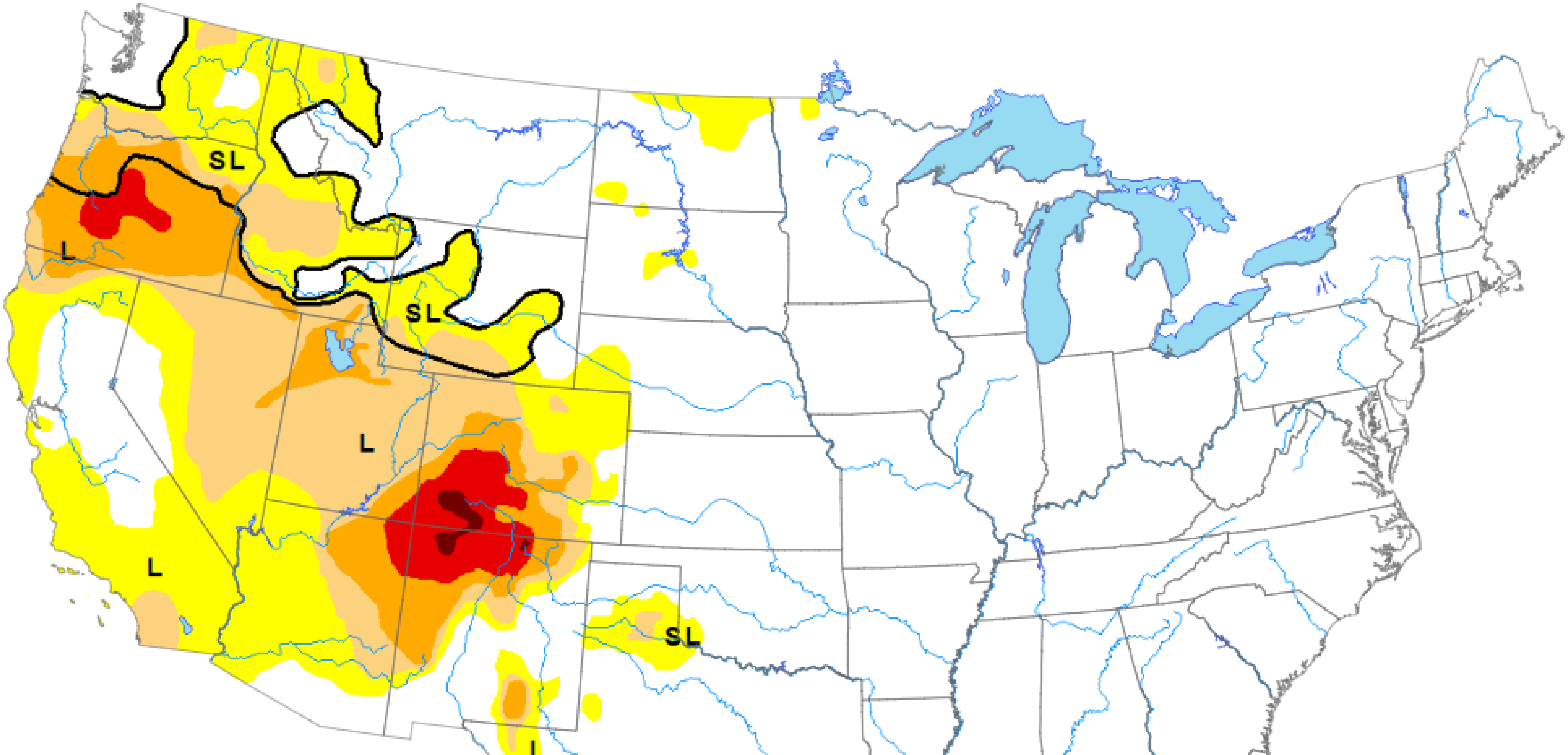
October 2017–September 2018

Period: 1895–2018



Map released: February 7, 2019

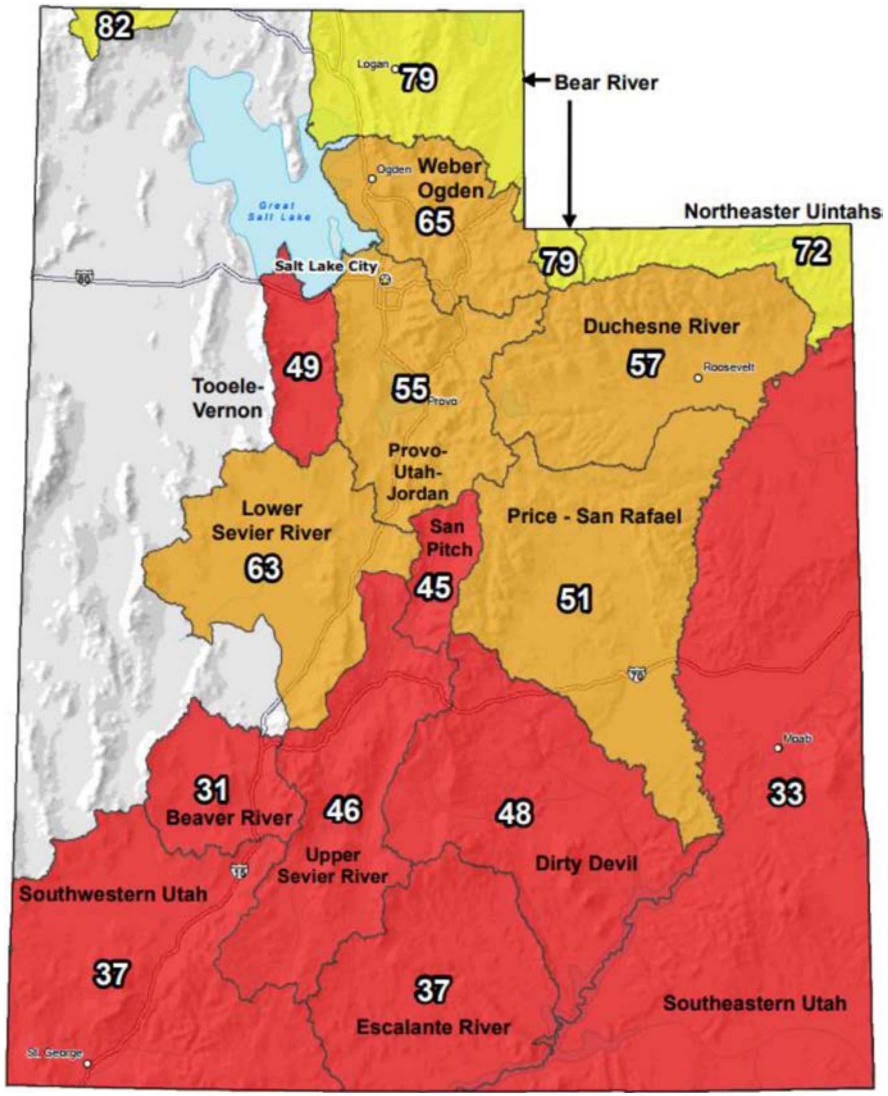
Data valid: February 5, 2019 | Author: Richard Tinker, NOAA/NWS/NCEP/CPC



Utah
SNOTEL Water Year (Oct 1) to Date Precipitation
O/o of Normal

Rai River

Jan 22, 2018



Water Year (Oct 1) to Date Precipitation Basin-wide Percent of 1981-2010 Average

[=i	unavailable •
...	<50%
[=:]	50 - 69%
c=J	70 - 89%
[=:]	90 - 109%
c=i	110 - 129%
	130 - 149%
...	>=150%

• Data unavaHable at tiTIff al posting or measurwnem ts not mpresentative at this ome otyear

Provis ional Data Subject to Revision

USDA NRCS

0 10 20 40 60 80 100 Miles

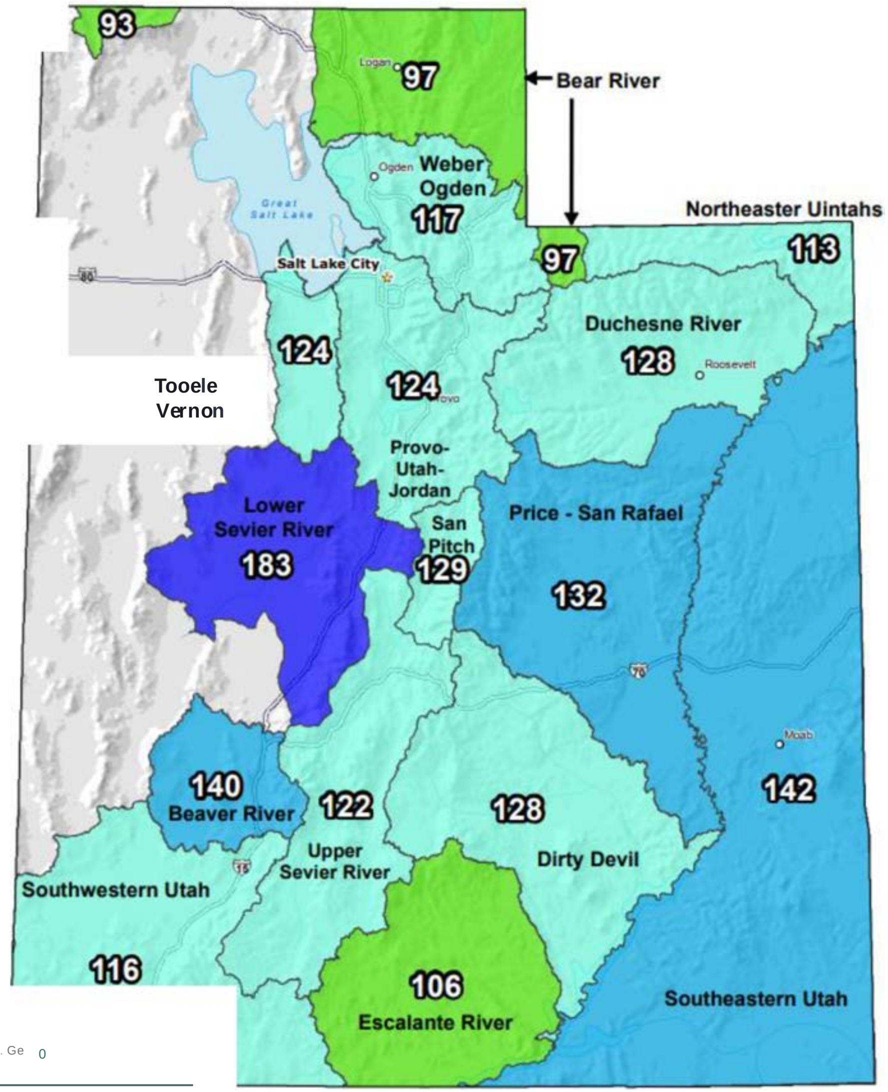
The water year to date precipllatlon percent of normal represents the accumulated precipitation roood at selected SNOTEL sitesIn ornear the basin compared to the average value ror !hose sites on !his day. Data based on lhe first reading of lhe day (typically 00:00).

Prepared by:
USDA/NRCS National Water and Climate Center
Penland. Oregon
http://Www.wcc.nrcs.usda.gov

Utah
SNOTEL Water Year (Oct 1) to Date Precipitation
O/o of Normal

Rai River

Jan 22, 2019



Water Year (Oct 1) to Date Precipitation Basin-wide Percent of 1981-2010 Average

[=i	unavailable •
...	<50%
[=:]	50-69%
c=J	70 - 89%
[=:]	90 - 109%
c=i	110-129%
la	130 - 149%
1111	>=150%

• Data unavaitable al time ol posting ormeasuremttnr ls nor n,p,esentativeat this bme ofyear

Provisional Data Subject to Revision

USDA NRCS

s.. Ge 0

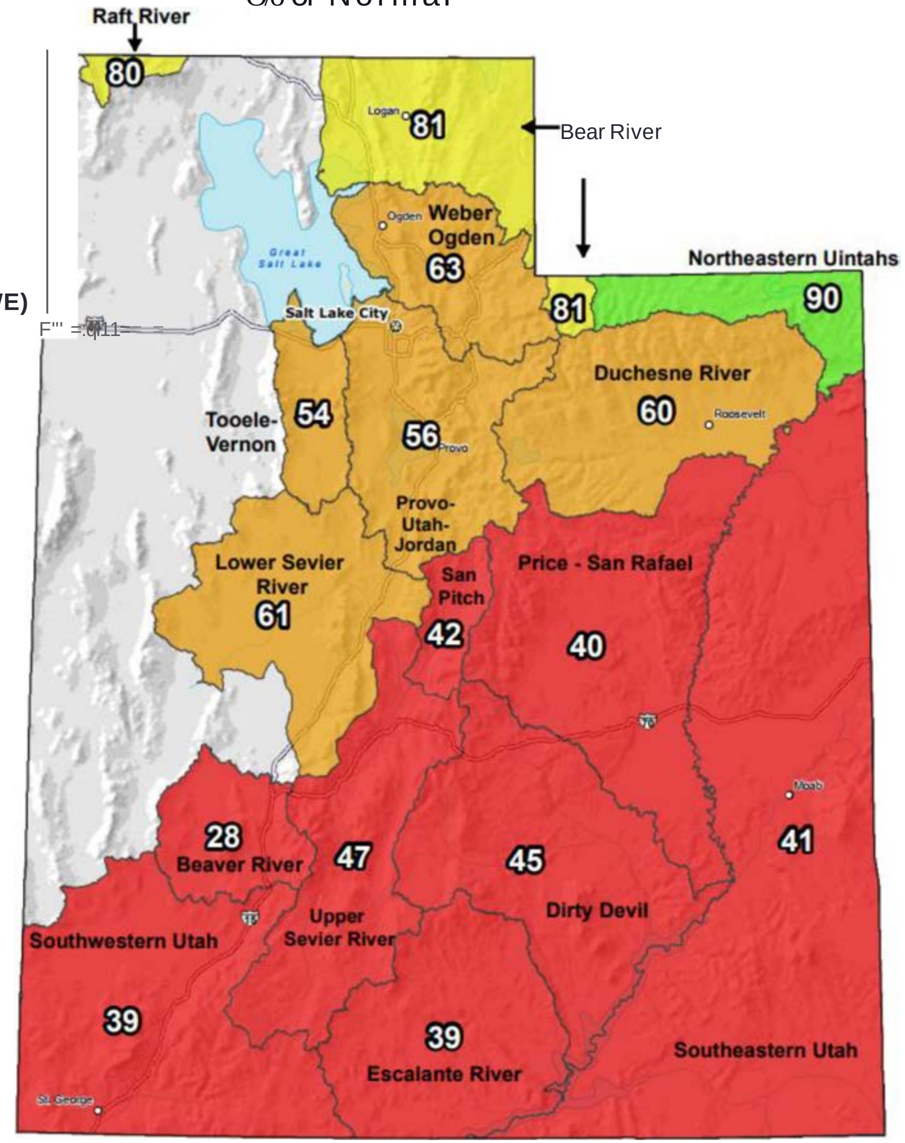
0 10 20 40 60 80 100 Miles

The water year to date precipitation percent of normal represents the accumulated precipitation foood at selected SNOTEL sites ,nor near the basin compared to the average value for lhose sites on lhls day. Data based on lhe first read,ng of lhe day (typically 00:00).

Prepared by:
USDAINRCS Nabonal Water and Climate Center
Portland. Oregon
http://Www.wcc.nrcs.usda.gov

Utah
SNOTEL Current Snow Water Equivalent (SWE)
% of Normal

Jan 22, 2018



Snow Water Equivalent **(SWE)** **Basin-wide** Percent of **1981-2010** **Median**

- unavailable*
- < 50%
- 50 - 69%
- 70 - 89%
- 90 - 109%
- 110 - 129%
- 130 - 149%
- > 150%

* *Data unavailable at time of posting or measurement is not representative at this time of year*

Provisional Data Subject to Revision

USDA NRCS

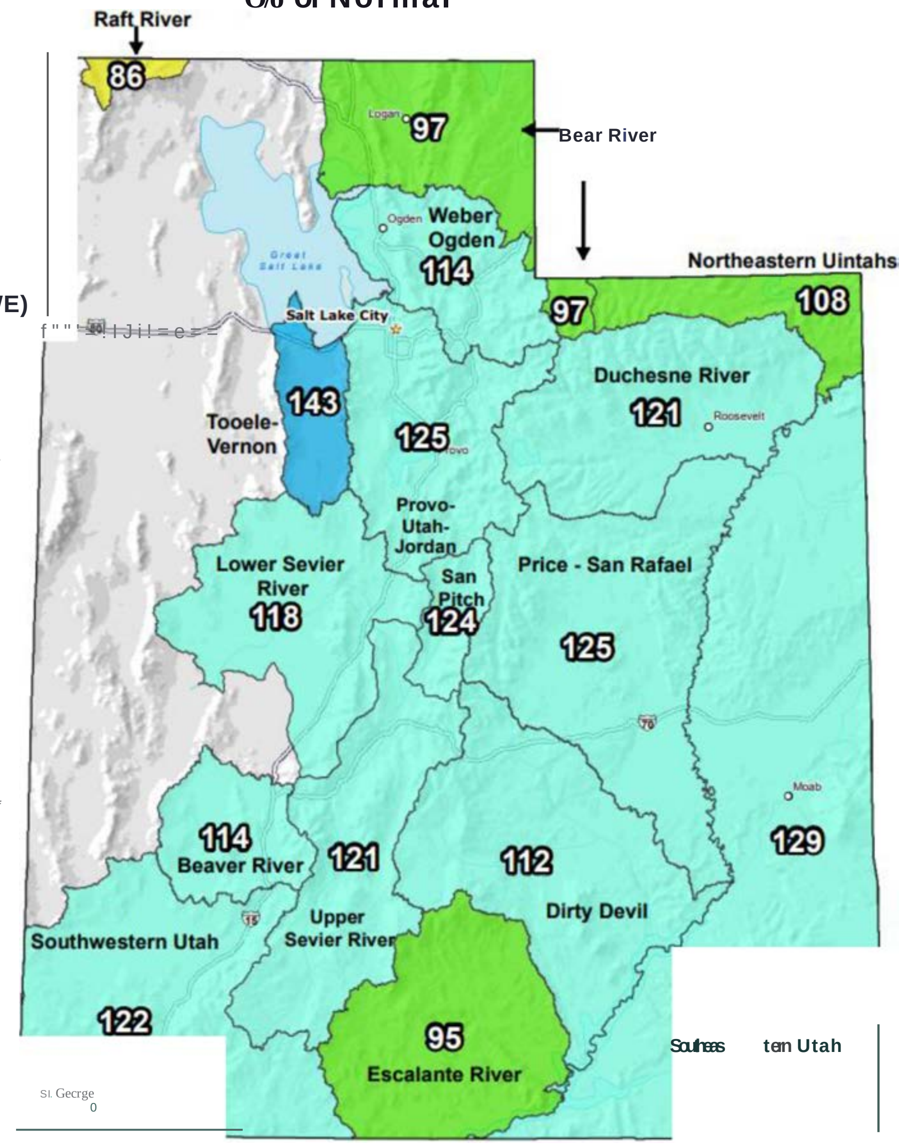
0 10 20 40 60 80 100 Miles

The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

Utah
SNOTEL Current Snow Water Equivalent (SWE)
% of Normal

Jan 22, 2019



Snow Water Equivalent (SWE) Basin-wide Percent of 1981-2010 Median

- unavailable*
- < 50%
- 50 - 69%
- 70 - 89%
- 90 - 109%
- 110 - 129%
- 130 - 149%
- > 150%

* *Data unavailable at time of posting or measurement is not representative at this time of year*

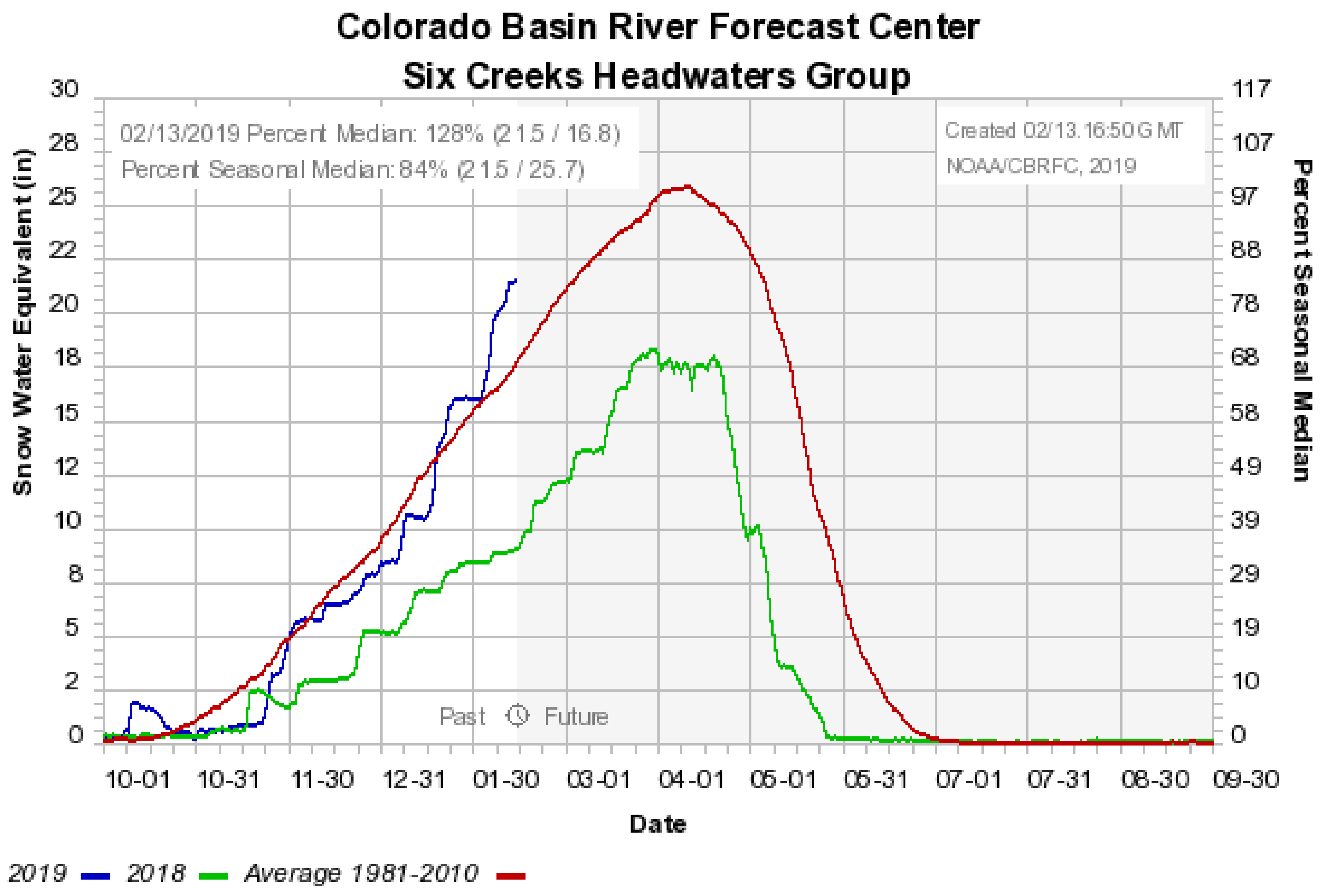
Provisional Data Subject to Revision

USDA NRCS

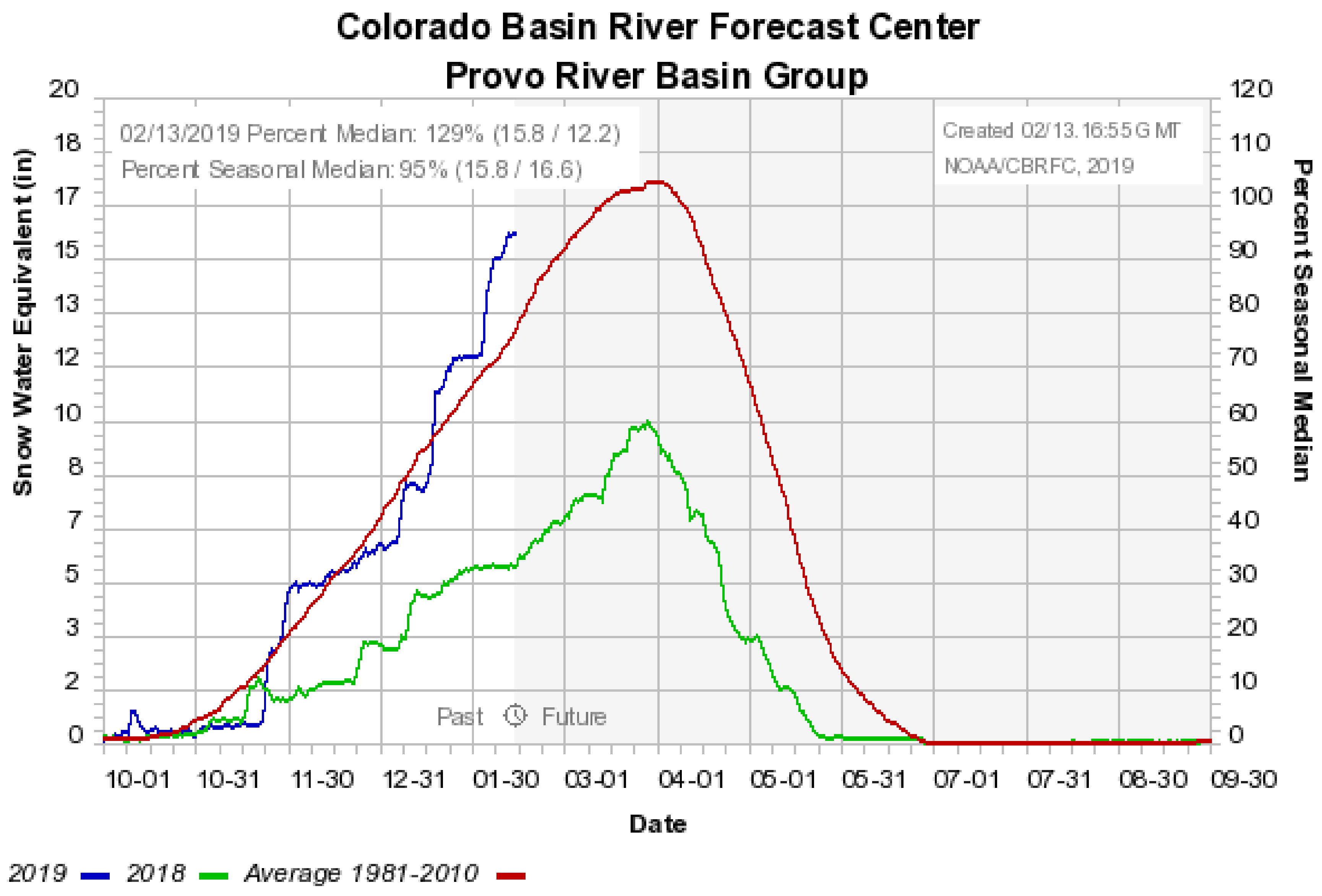
0 10 20 40 60 80 100 Miles

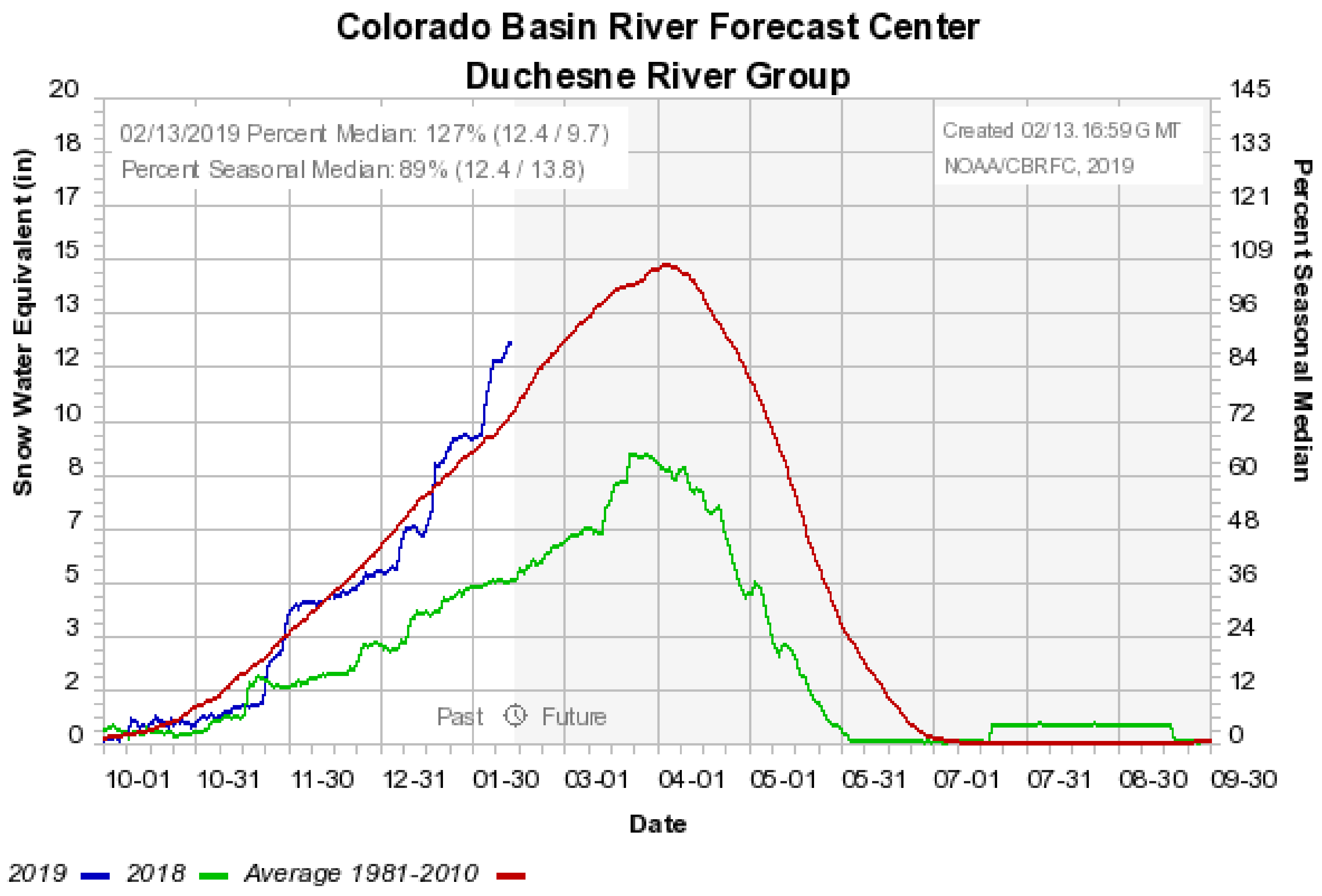
The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

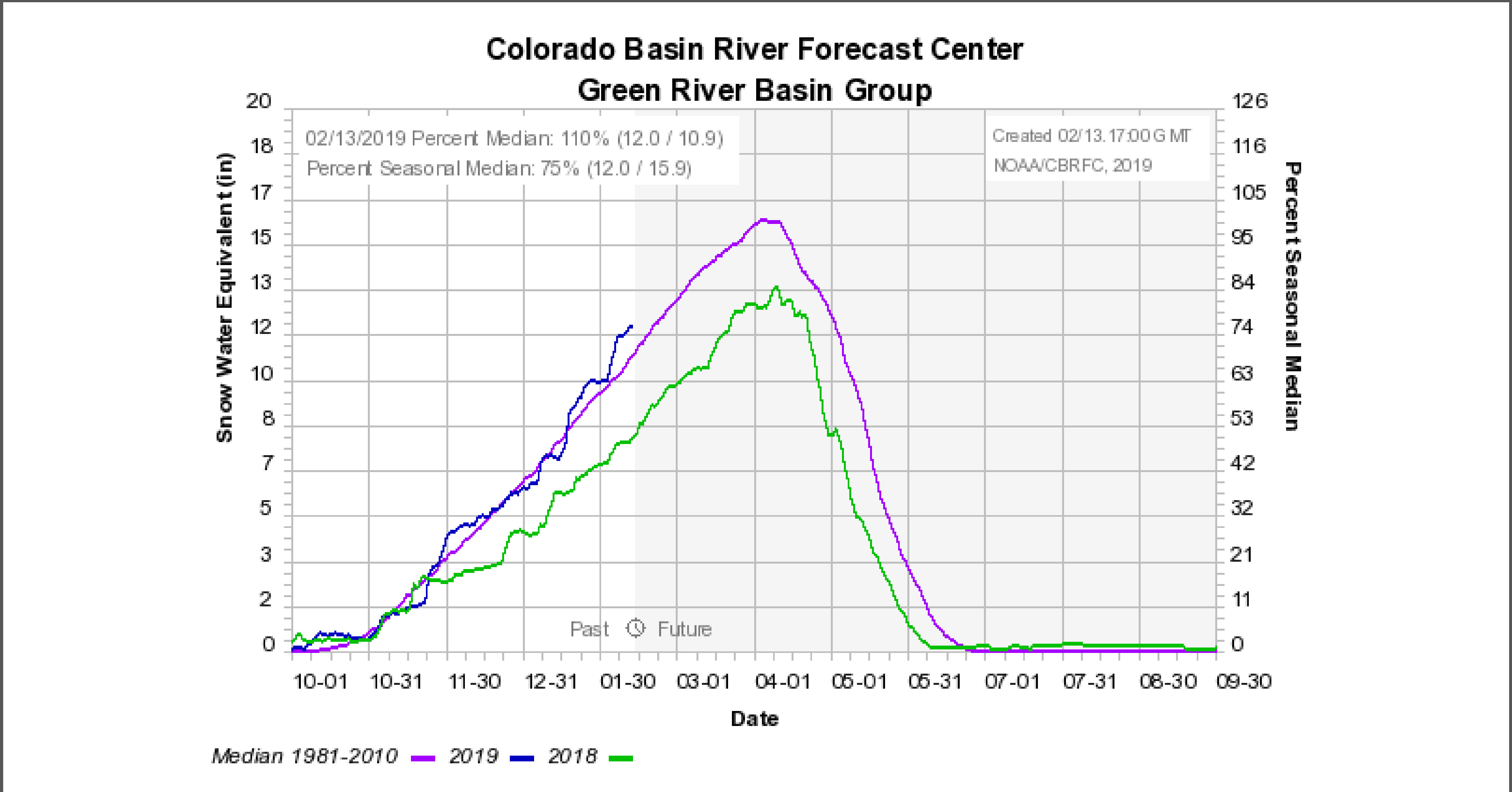


Colorado Basin River Forecast Center
Six Creeks Headwaters Group
02/13/2019 Percent Median: 128% (21.5 / 16.8)
Percent Seasonal Median: 84% (21.5 / 25.7)
Created 02/13.16:50 GMT
NOAA/CBRFC, 2019
Snow Water Equivalent (in)
Percent Seasonal Median
30
28
25
22
20
18
15
12
10
8
5
2
0
117
107
97
88
78
68
58
49
39
29
19
10
0
Past
Future
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
Date
2019
2018
Average 1981-2010


Colorado Basin River Forecast Center
Provo River Basin Group
02/13/2019 Percent Median: 129% (15.8 / 12.2)
Percent Seasonal Median: 95% (15.8 / 16.6)
Created 02/13.16:55 GMT
NOAA/CBRFC, 2019
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
Date
2019
2018
Average 1981-2010



Colorado Basin River Forecast Center
Duchesne River Group
02/13/2019 Percent Median: 127% (12.4 / 9.7)
Percent Seasonal Median: 89% (12.4 / 13.8)
Created 02/13 16:59 GMT
NOAA/CBRFC, 2019
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
2019
2018
Average 1981-2010

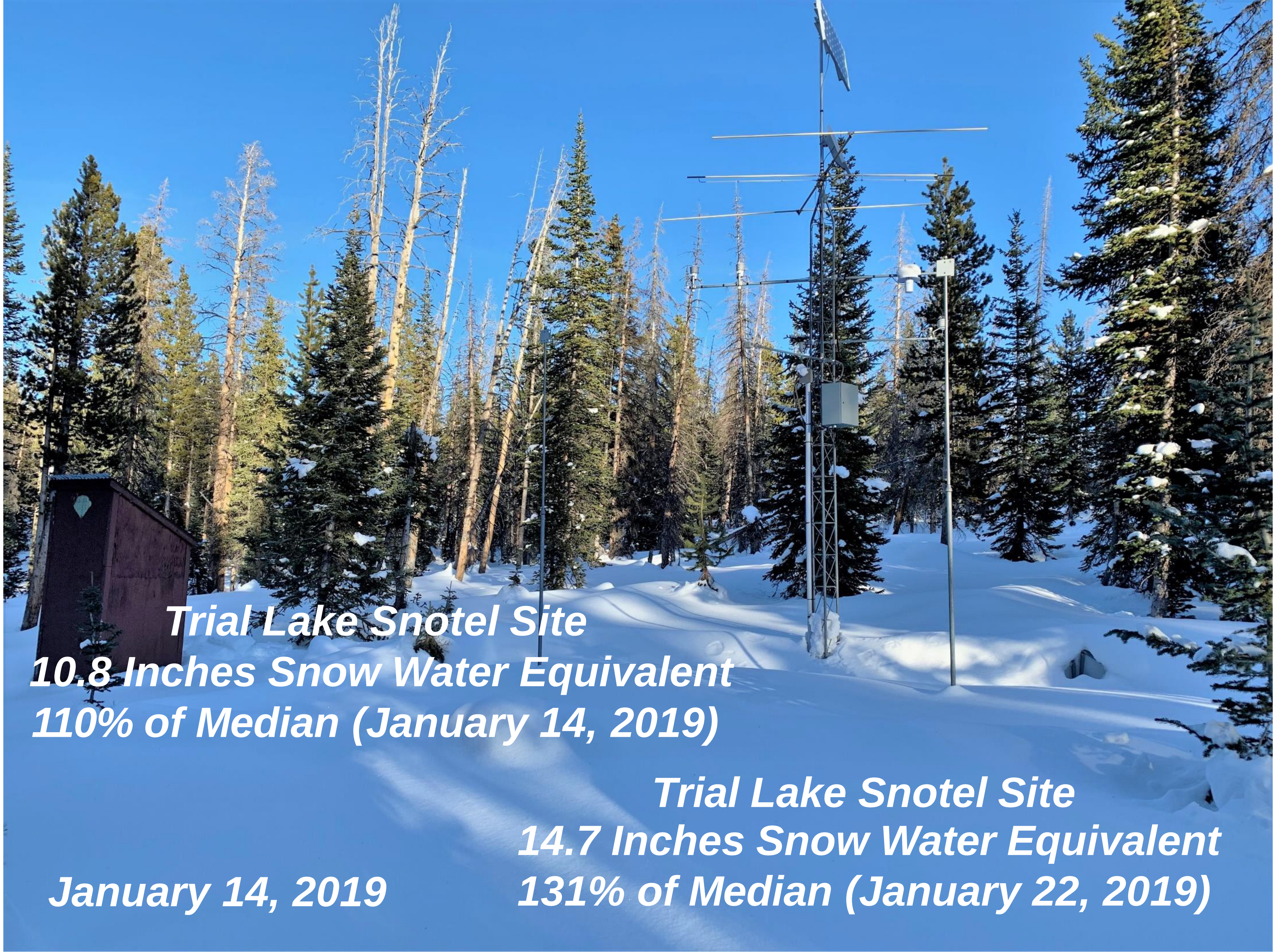


Colorado Basin River Forecast Center
Green River Basin Group
02/13/2019 Percent Median: 110% (12.0 / 10.9)
Percent Seasonal Median: 75% (12.0 / 15.9)
Created 02/13.17:00 GMT
NOAA/CBRFC, 2019
Snow Water Equivalent (in)
Percent Seasonal Median
Past
Future
Date
10-01
10-31
11-30
12-31
01-30
03-01
04-01
05-01
05-31
07-01
07-31
08-30
09-30
0
2
3
5
7
8
10
12
13
15
17
18
20
0
11
21
32
42
53
63
74
84
95
105
116
126
Median 1981-2010
2019
2018

January 17, 2018 ***Trial Lake Campground***

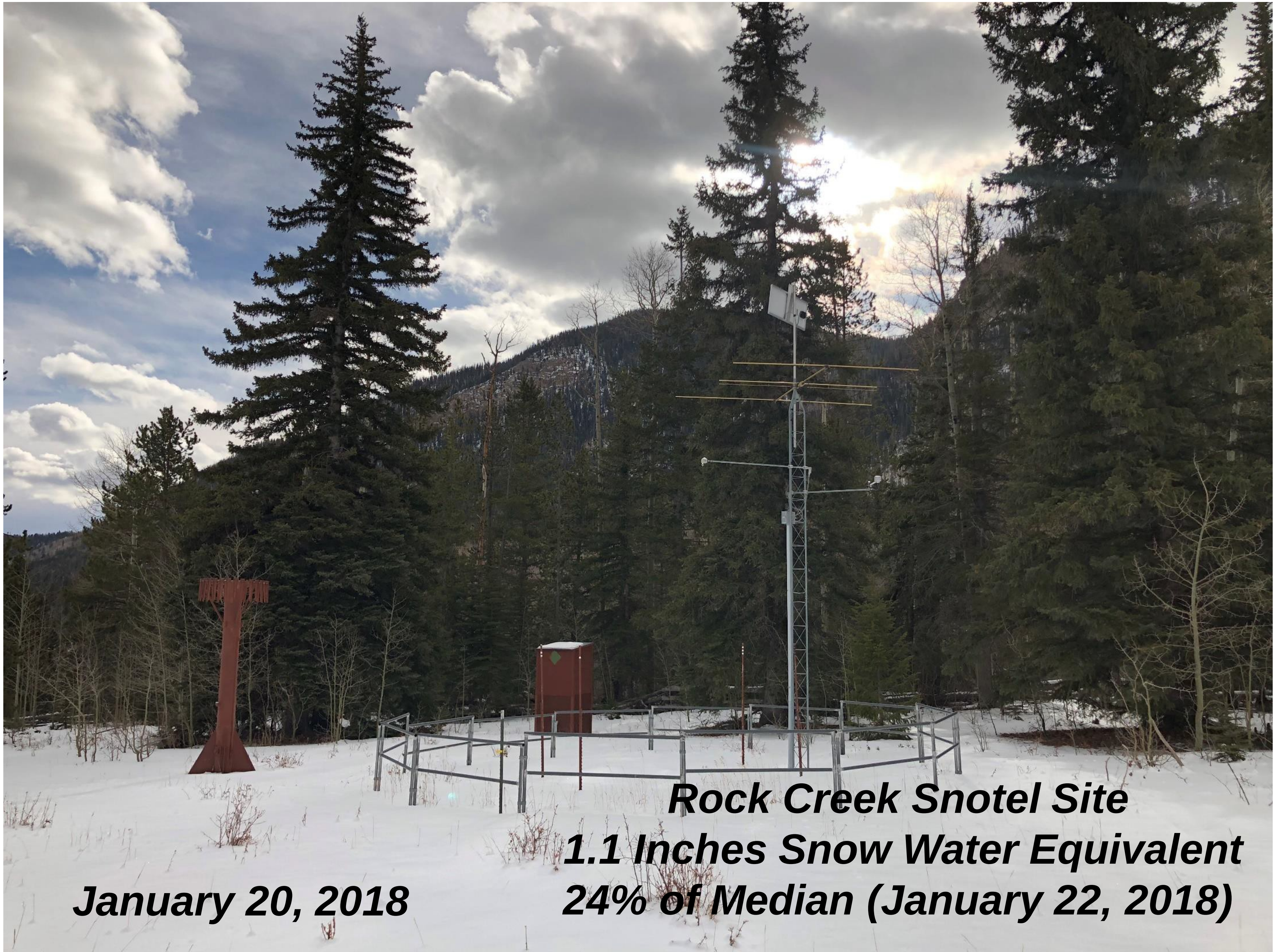

January 14, 2019
Trial Lake Campground


January
17, 2018
Trial Lake Snotel Site
10.1 Inches Snow Water Equivalent
90% of Median (January 22, 2018)

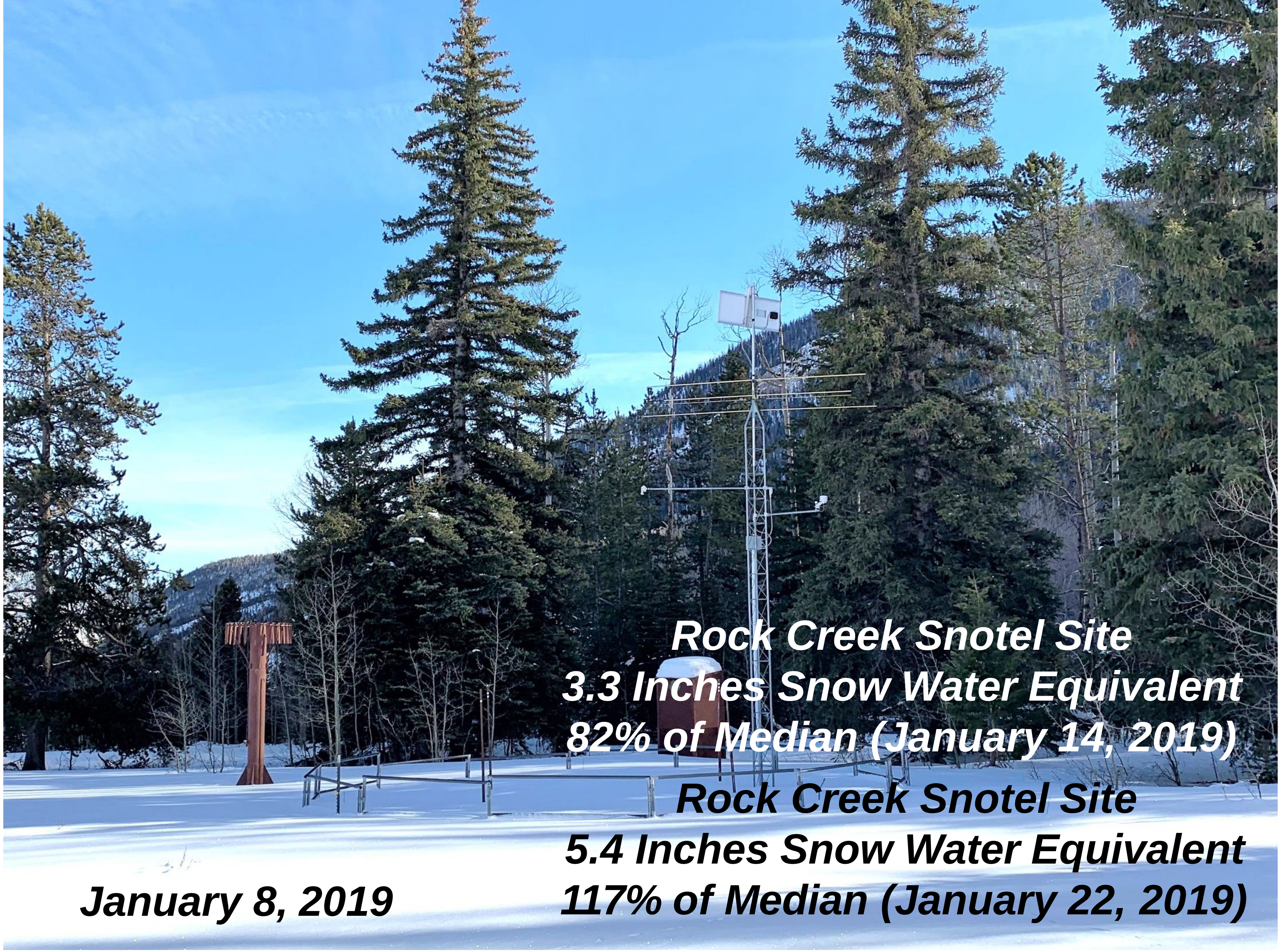

Trial Lake Snotel Site
10.8 Inches Snow Water Equivalent
110% of Median (January 14, 2019)
Trial Lake Snotel Site
14.7 Inches Snow Water Equivalent
131% of Median (January 22, 2019)
January 14, 2019


January 18, 2018
Restroom at Bald Pass

January 14, 2019 *Restroom at Bald Pass*



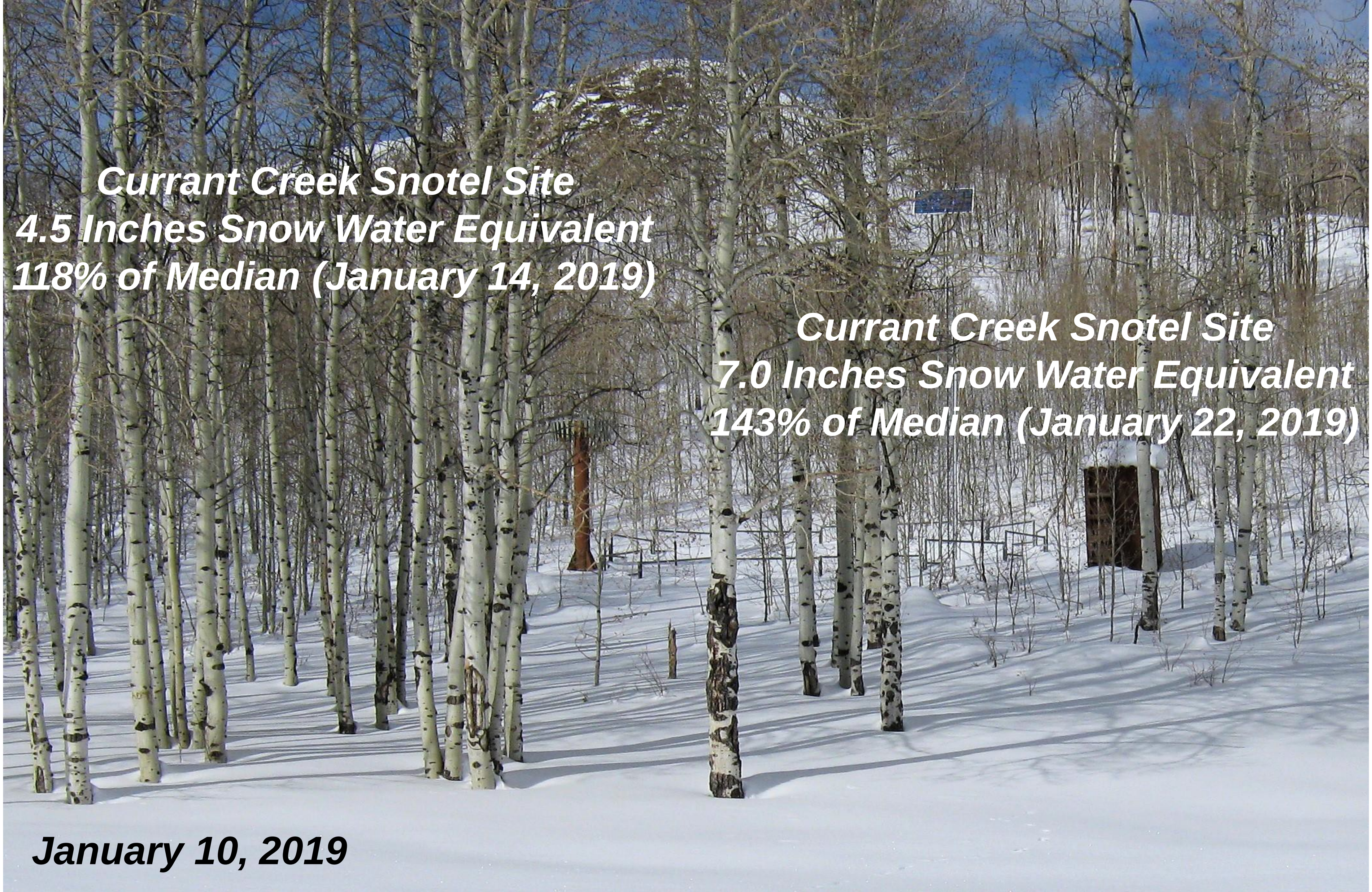
Rock Creek Snotel Site
1.1 Inches Snow Water Equivalent
24% of Median (January 22, 2018)
January 20, 2018


Rock Creek Snotel Site
3.3 Inches Snow Water Equivalent
82% of Median (January 14, 2019)
Rock Creek Snotel Site
5.4 Inches Snow Water Equivalent
117% of Median (January 22, 2019)
January 8, 2019


January 20, 2018
Upper Stillwater Dam


January 10, 2019
Upper Stillwater Dam


Currant Creek Snotel Site
2.3 Inches Snow Water Equivalent
47% of Median (January 22, 2018)
January 17, 2018


Currant Creek Snotel Site
4.5 Inches Snow Water Equivalent
118% of Median (January 14, 2019)
Currant Creek Snotel Site
7.0 Inches Snow Water Equivalent
143% of Median (January 22, 2019)
January 10, 2019


January 18, 2018
Strawberry Valley - Trout Creek


January 8, 2019
Strawberry Valley - Trout Creek


January 20, 2019
Strawberry Valley - Trout Creek


January 18, 2018
SWUA Property – Strawberry Valley


January 8, 2019
SWUA Property – Strawberry Valley

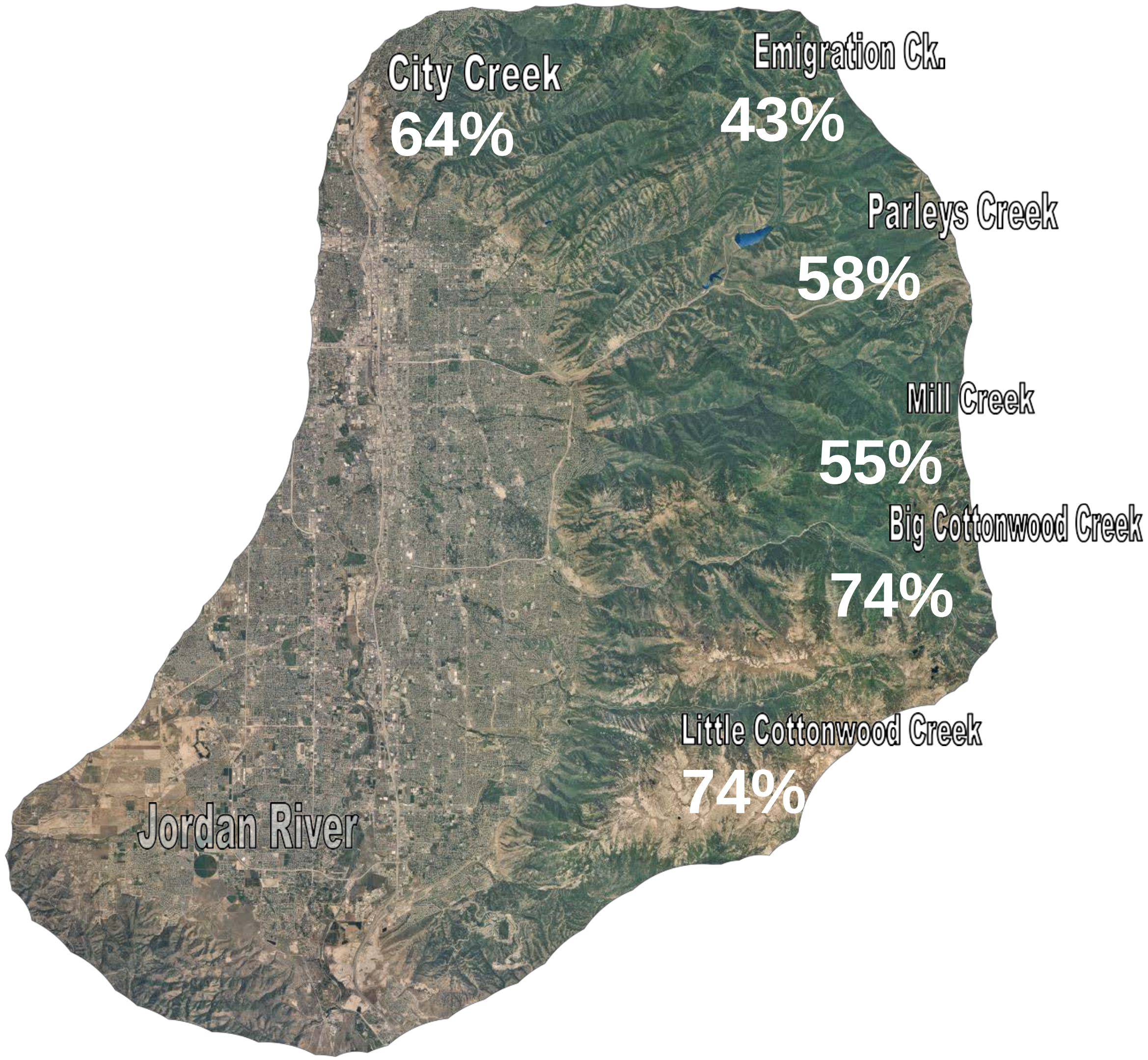

Daniel's/Strawberry Snotel Site
7.1 Inches Snow Water Equivalent
113% of Median (January 14, 2019)
Daniel's/Strawberry Snotel Site
10.8 Inches Snow Water Equivalent
132% of Median (January 22, 2019)
January 10, 2019

January 1, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Six Creeks River Basin

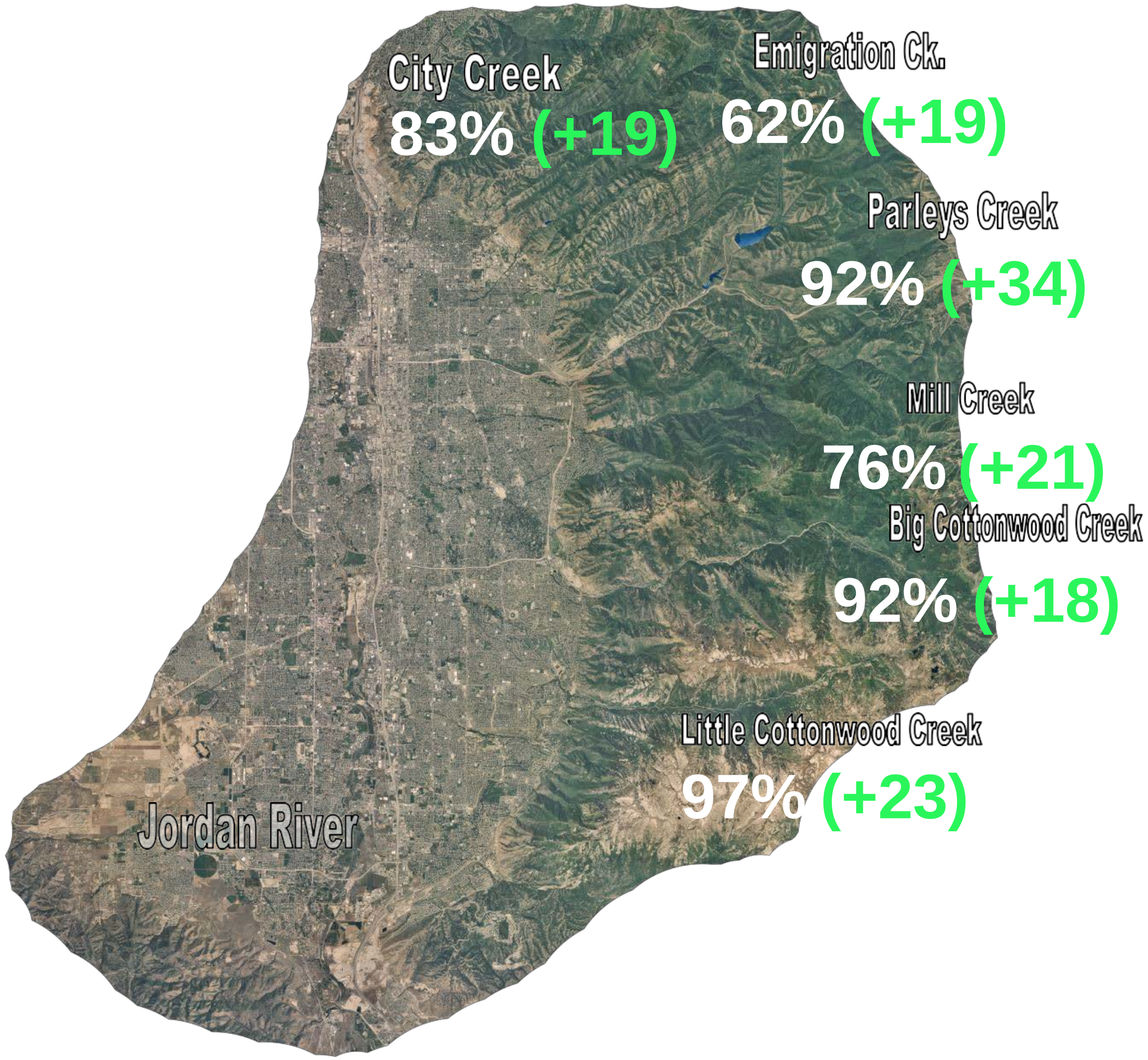


January 22, 2019

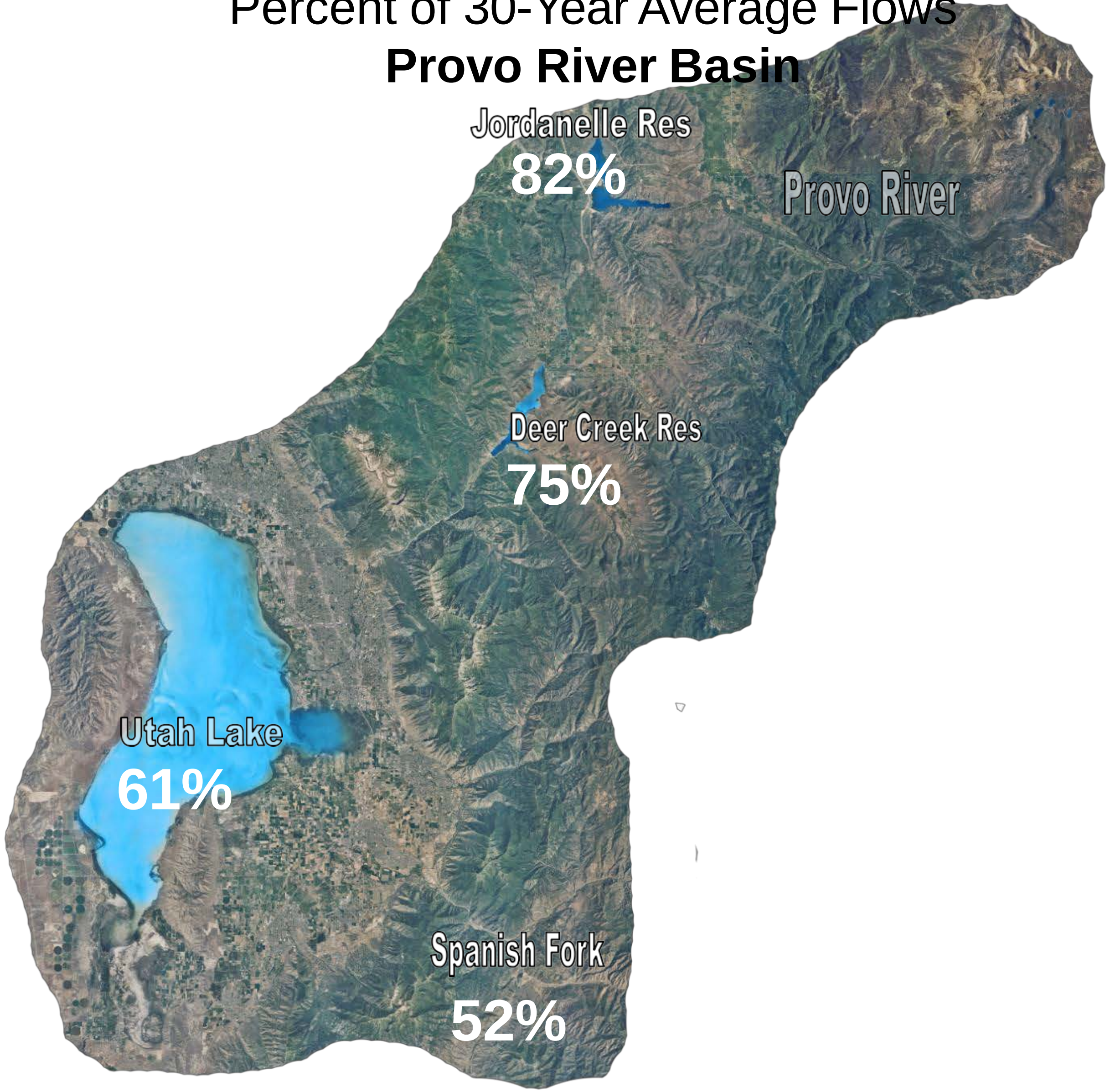
April-Through-July Volume Forecast

Percent of 30-Year Average Flows

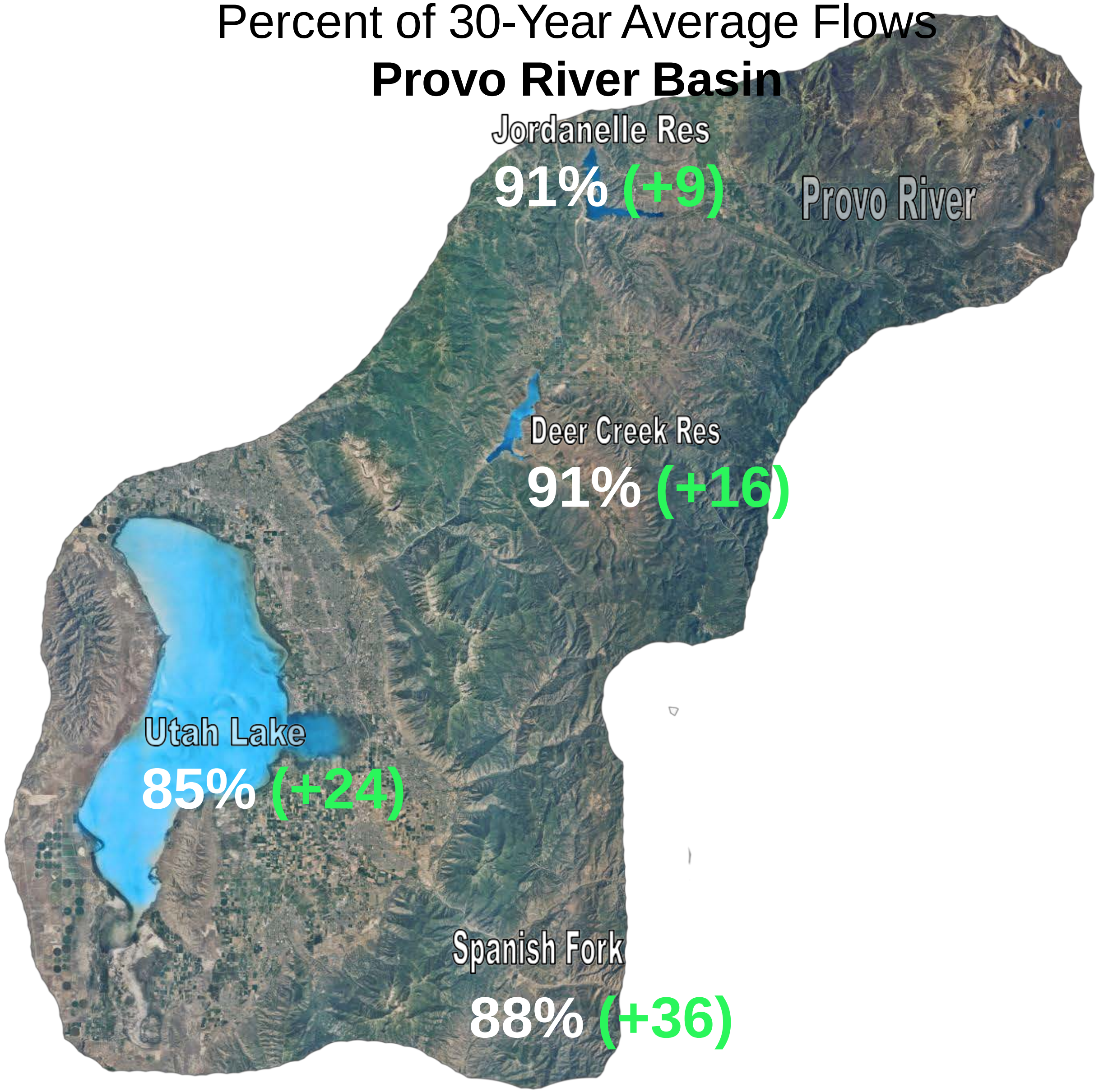
Six Creeks River Basin



January 1, 2019
April-Through-July Volume Forecast
Percent of 30-Year Average Flows
Provo River Basin



January 22, 2019
April-Through-July Volume Forecast
Percent of 30-Year Average Flows
Provo River Basin




January 17, 2018


January 14, 2019

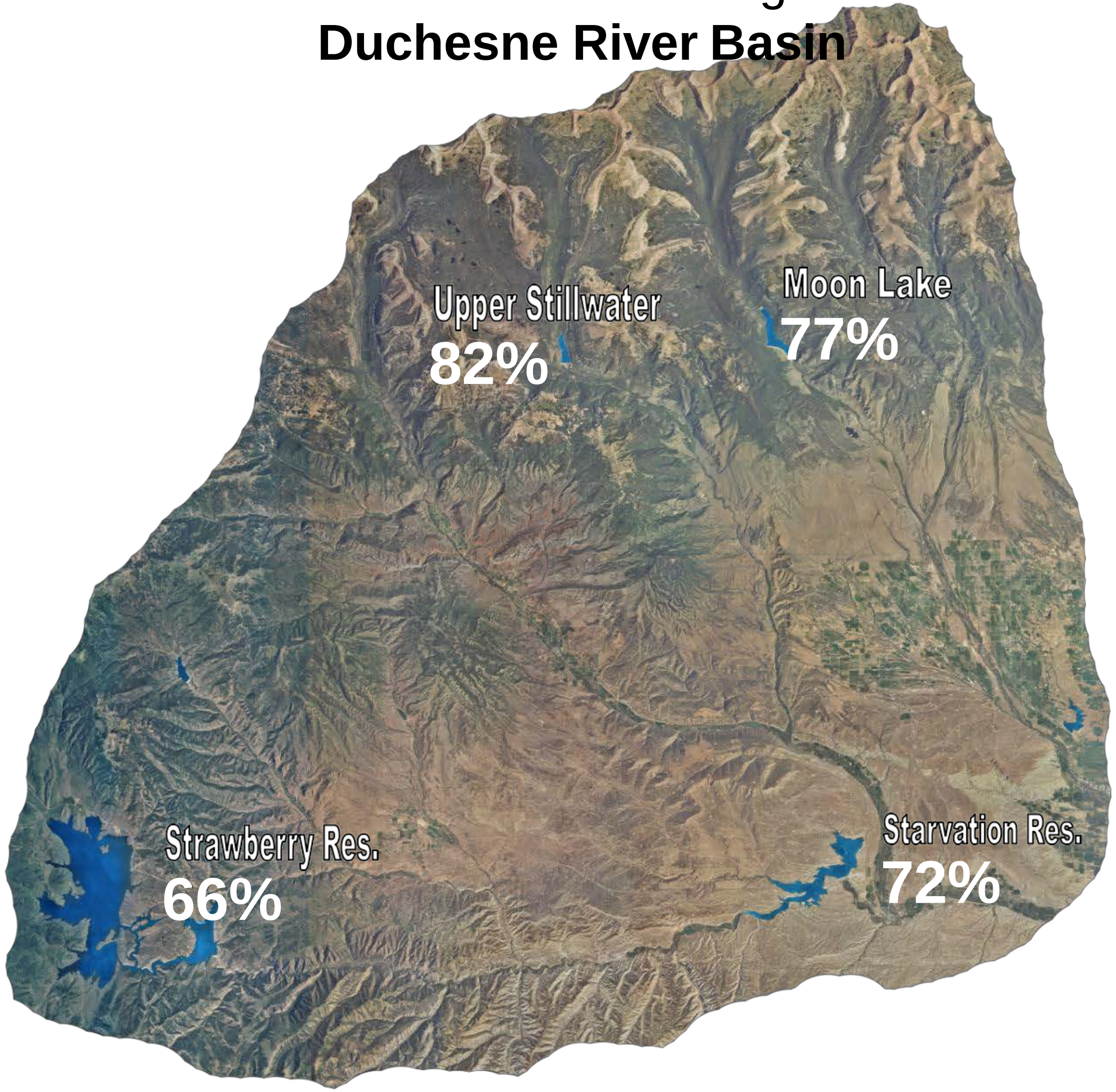
Forecasted Utah Spring Snowmelt Runoff Volume

January 1, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Duchesne River Basin



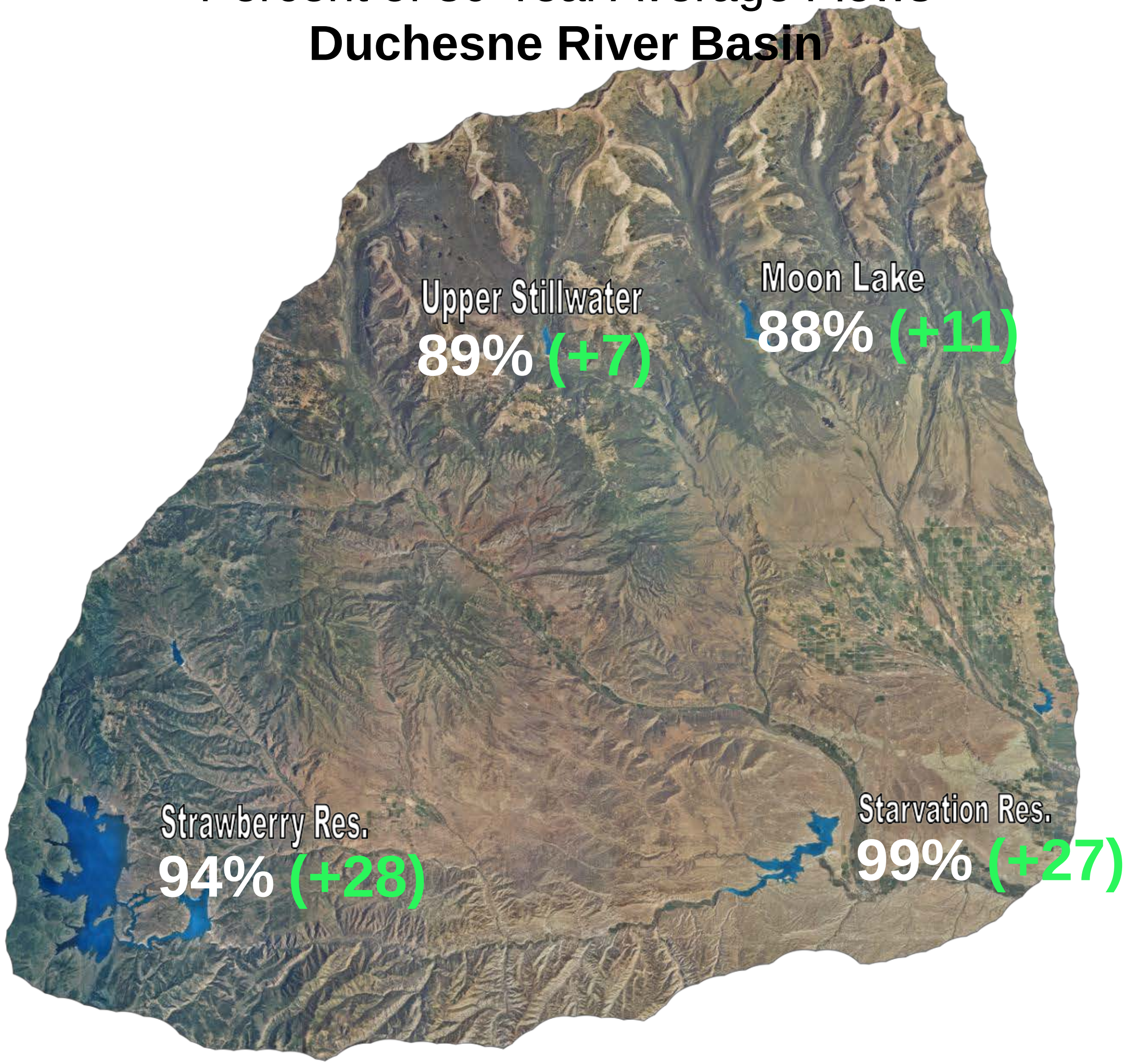
Forecasted Utah Spring Snowmelt Runoff Volume

January 22, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Duchesne River Basin




January 14, 2019
Currant
Creek

January 2019

Open Channel No. 2
(The Ladders)

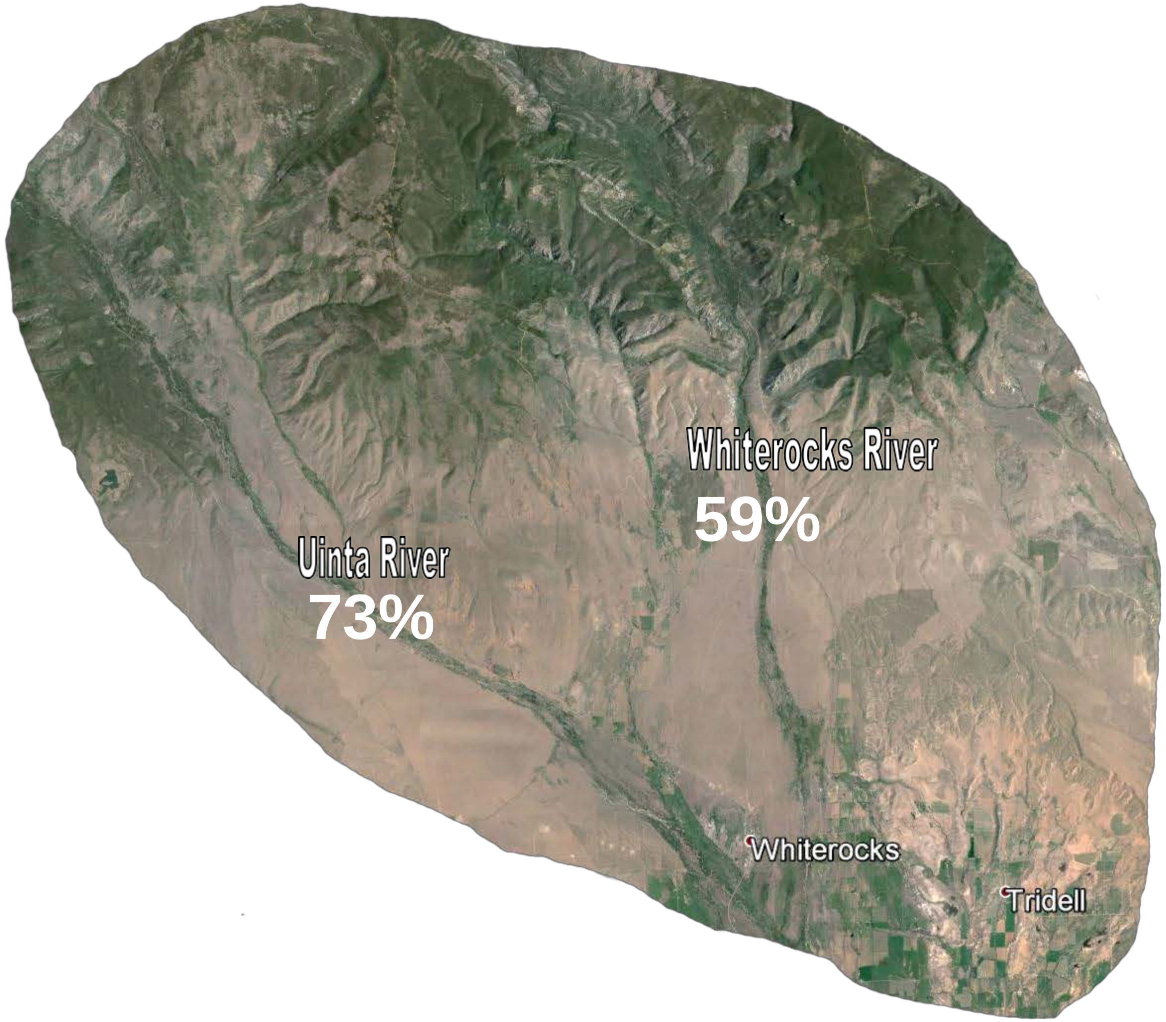

January 20, 2019
Deep Creek
Dollar Ridge Fire

January 1, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Uinta River/Whiterocks River

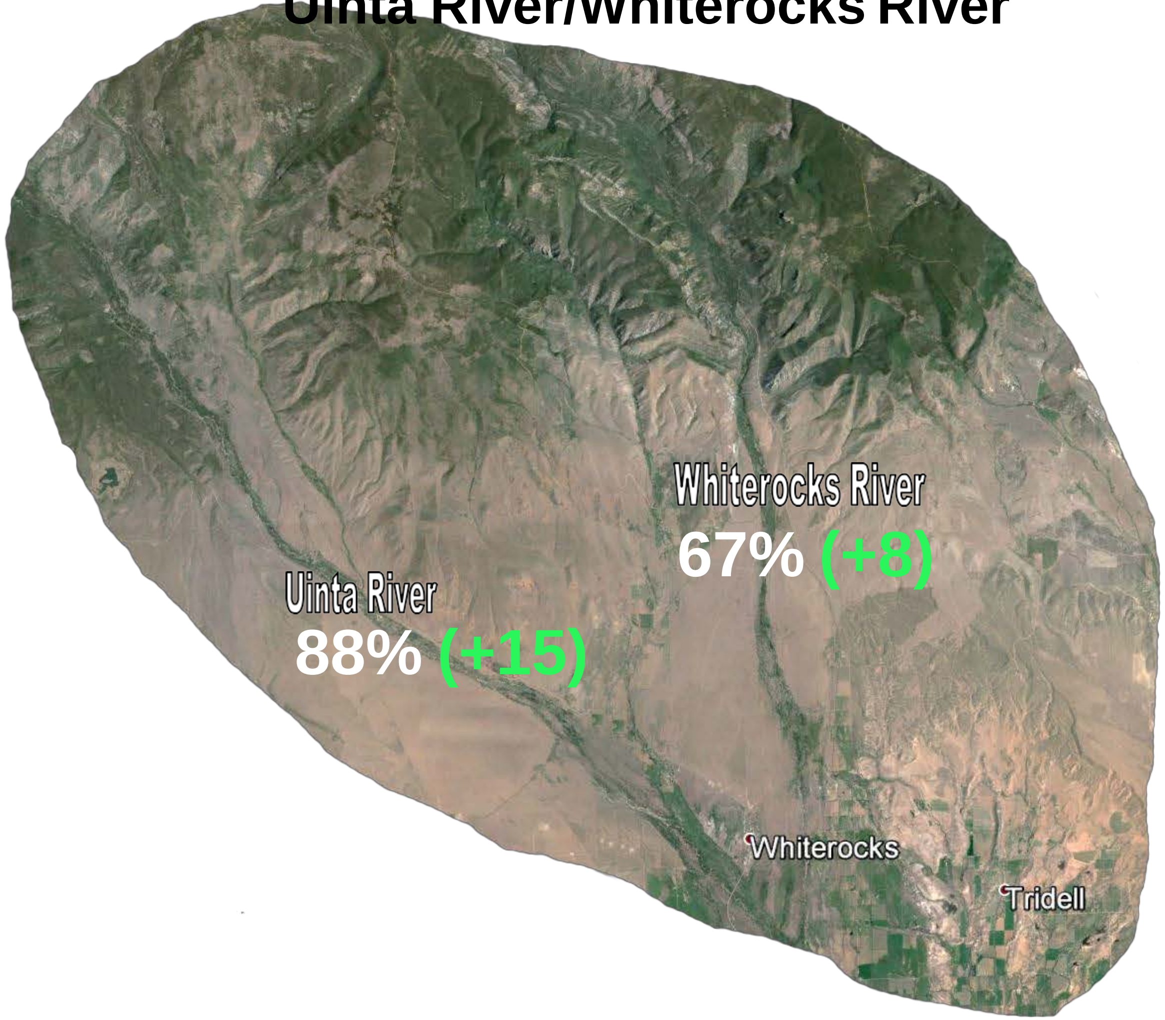


January 22, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Uinta River/Whiterocks River

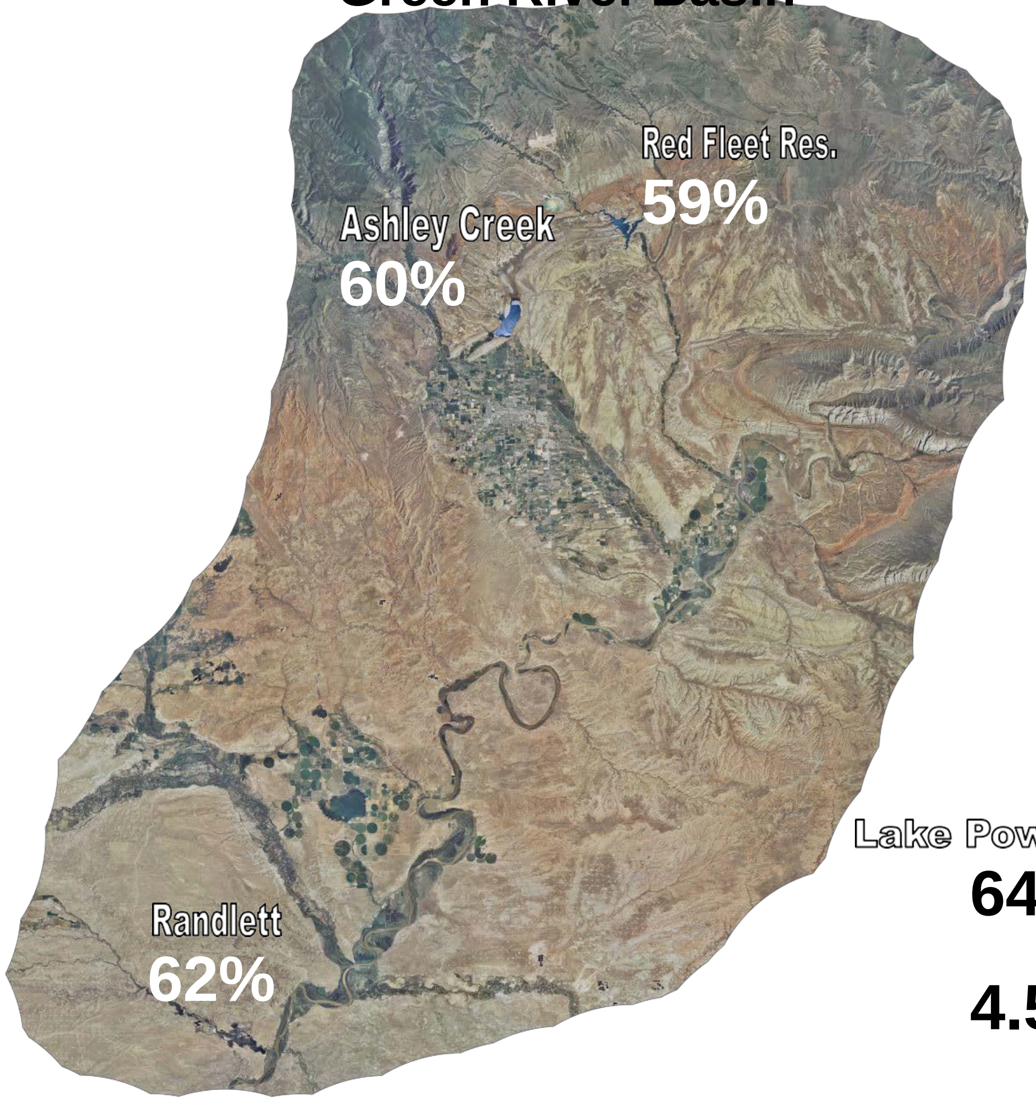


January 1, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Green River Basin



Flaming Gorge

64%

630K AF

Lake Powell

64%

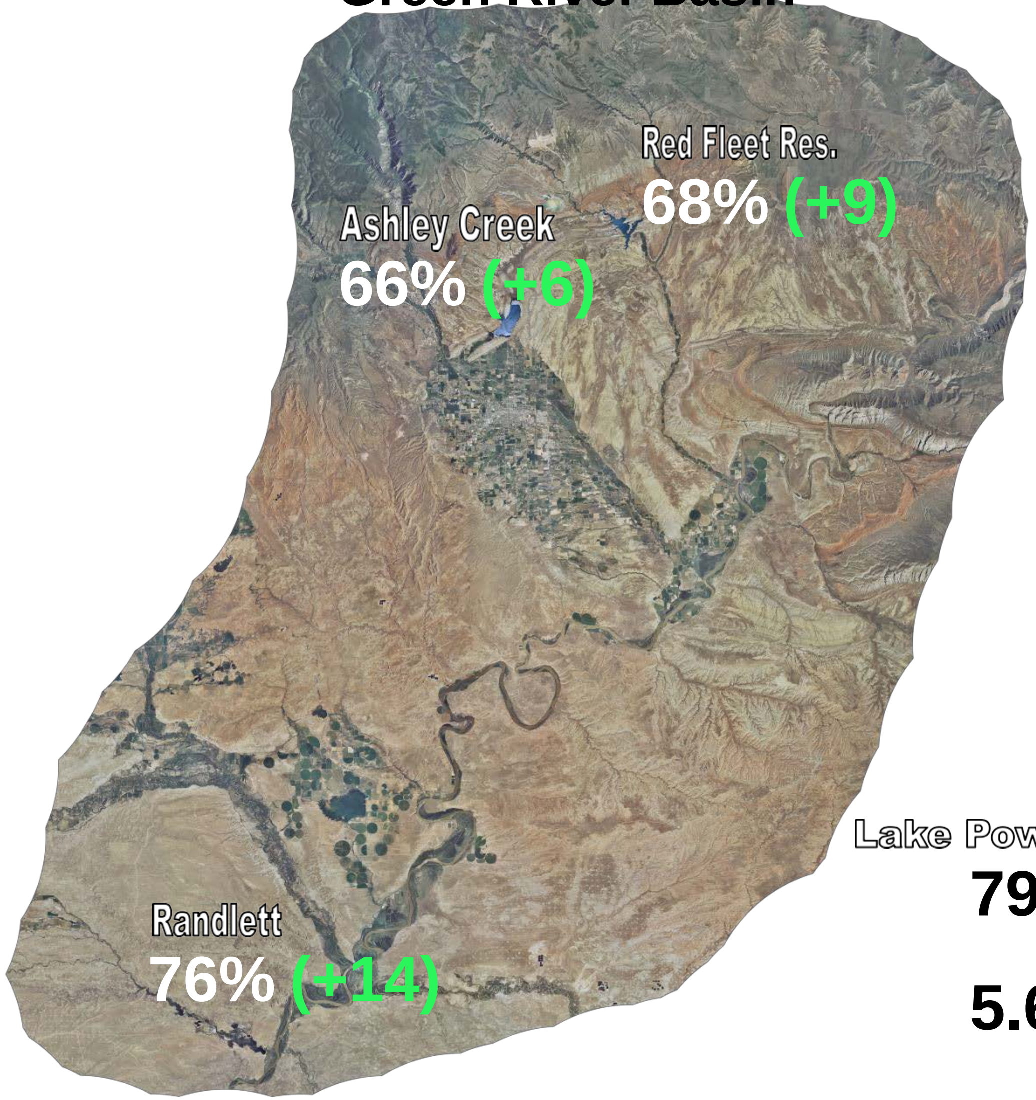
4.55M AF

January 22, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Green River Basin



Flaming Gorge

71% (+7)

696K AF (+66K)

Lake Powell

79% (+15)

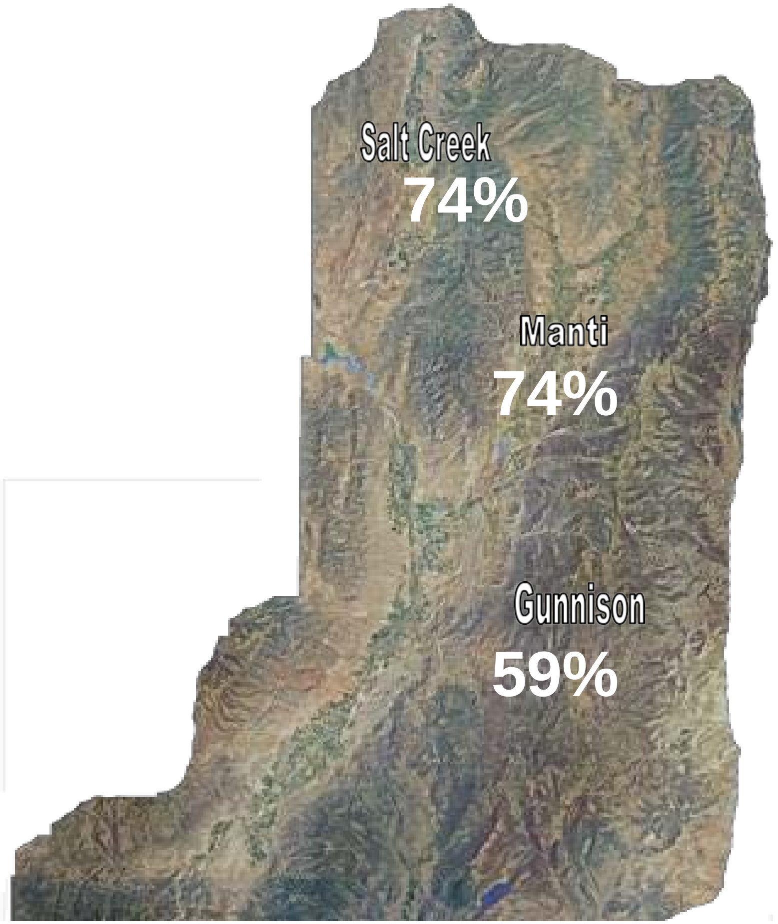
5.63M AF (+1.08M)

January 1, 2019

April-Through-July Volume Forecast

Percent of 30-Year Average Flows

Sevier River Basin

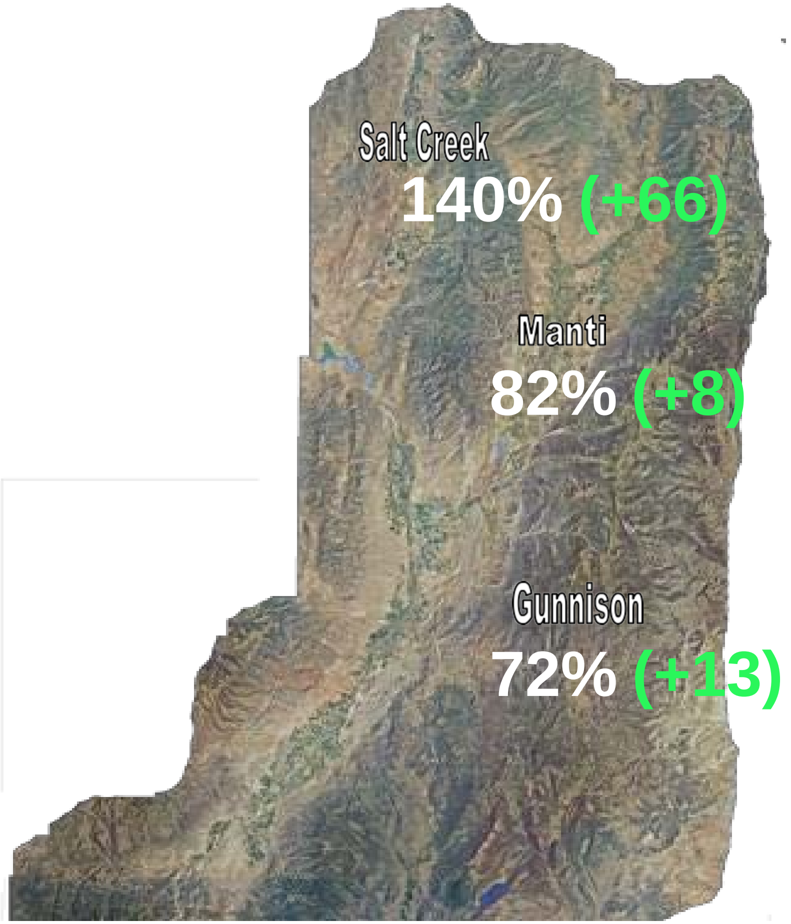


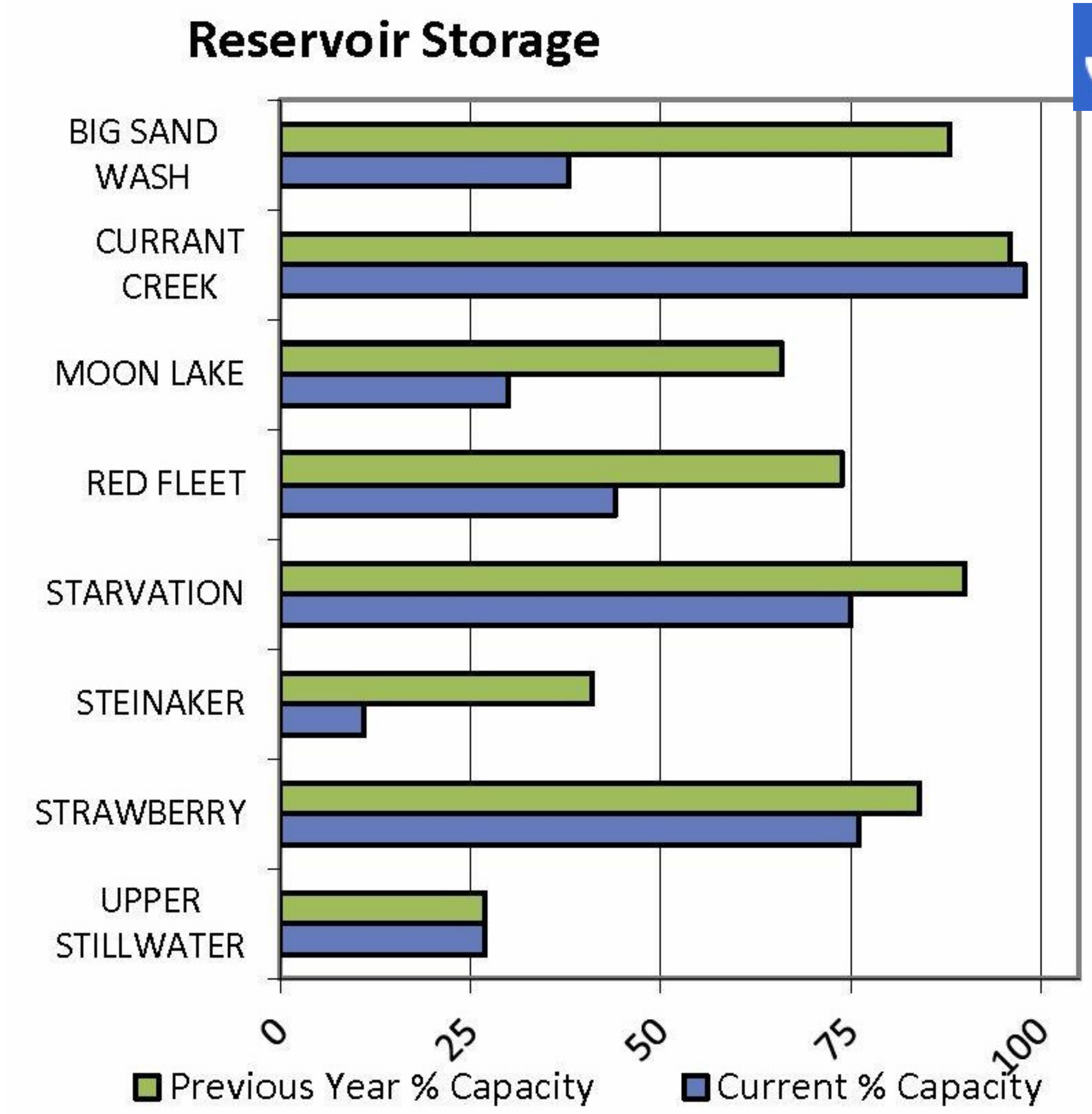
January 22, 2019

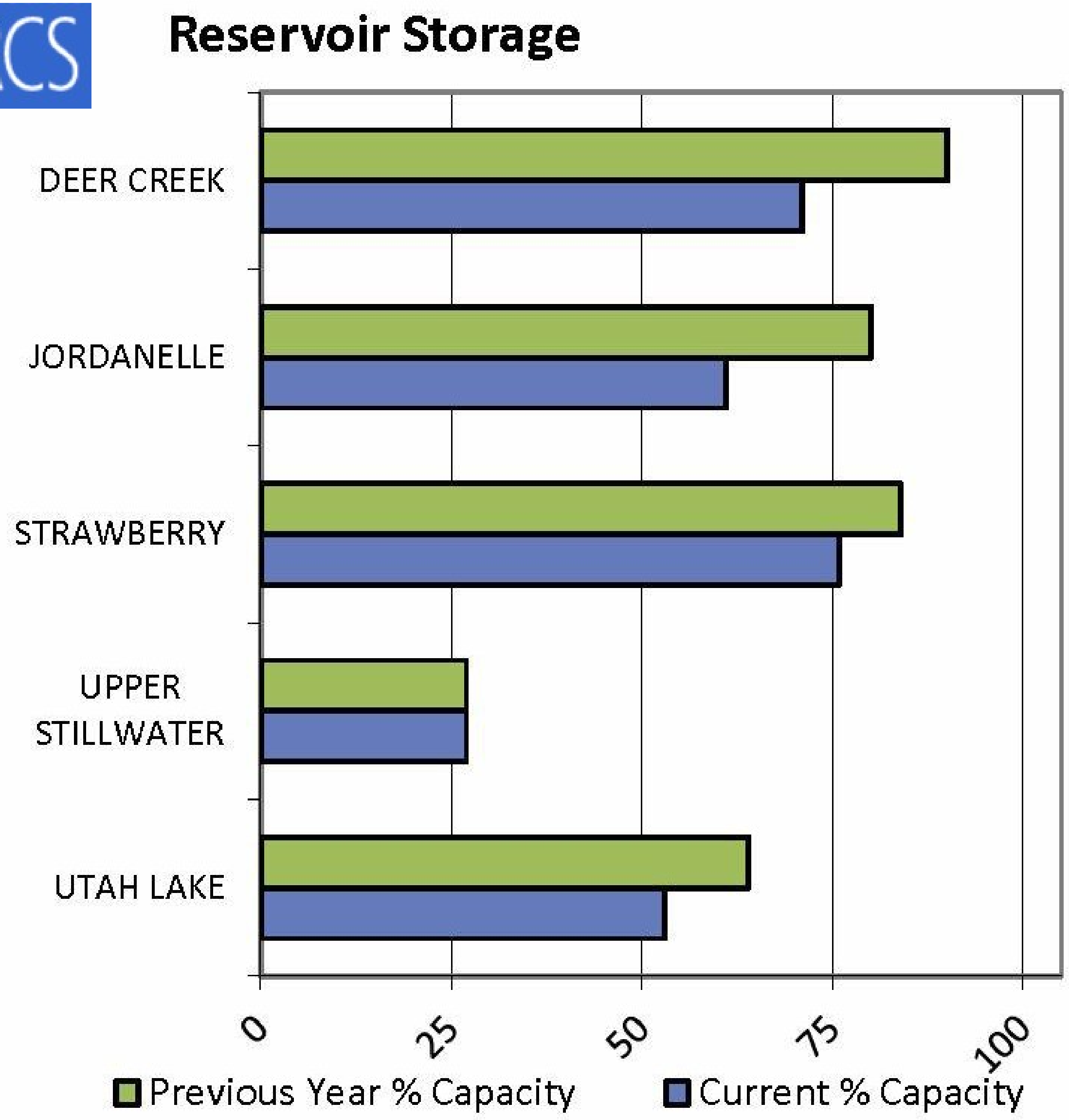
April-Through-July Volume Forecast

Percent of 30-Year Average Flows

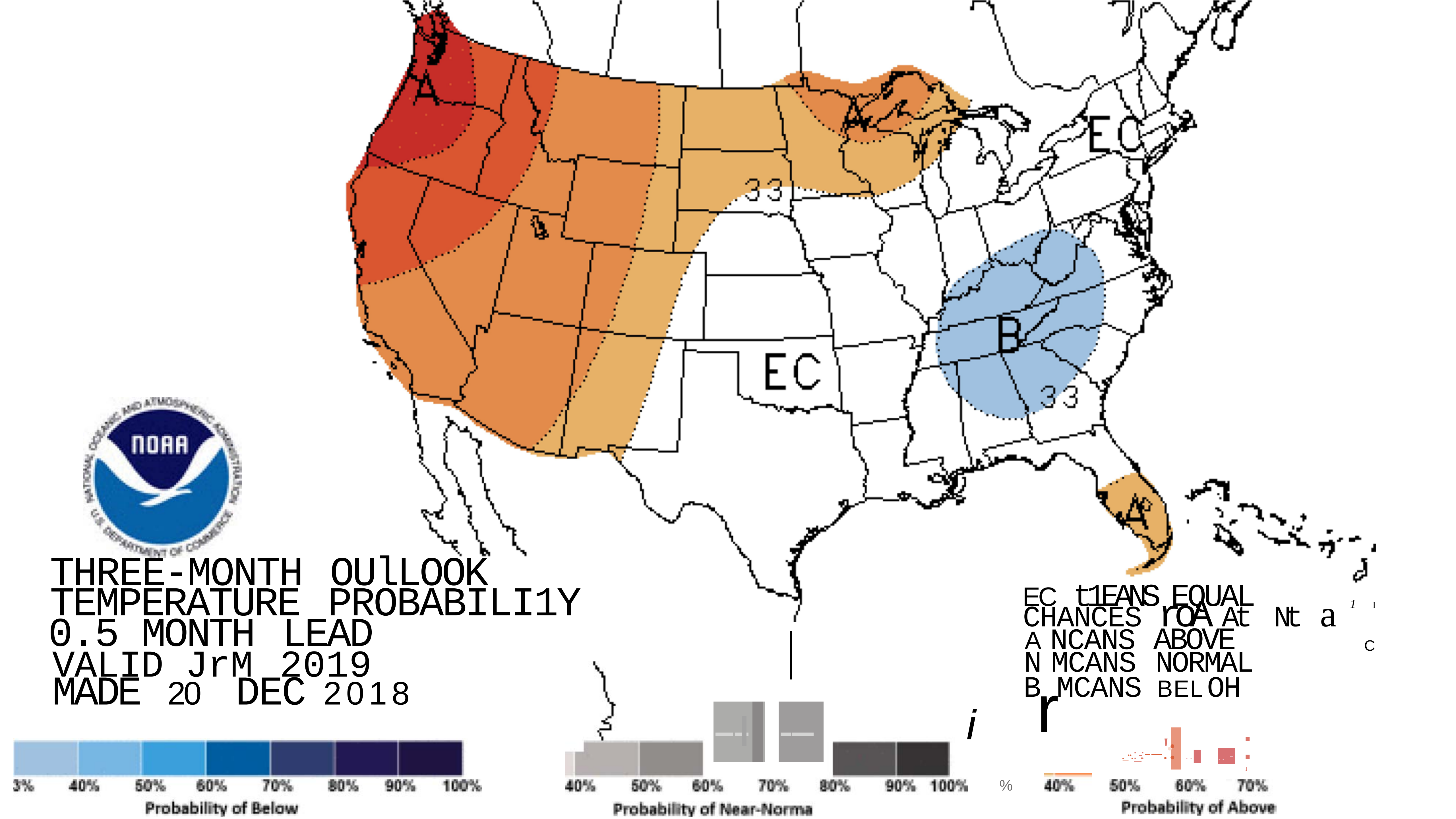
Sevier River Basin







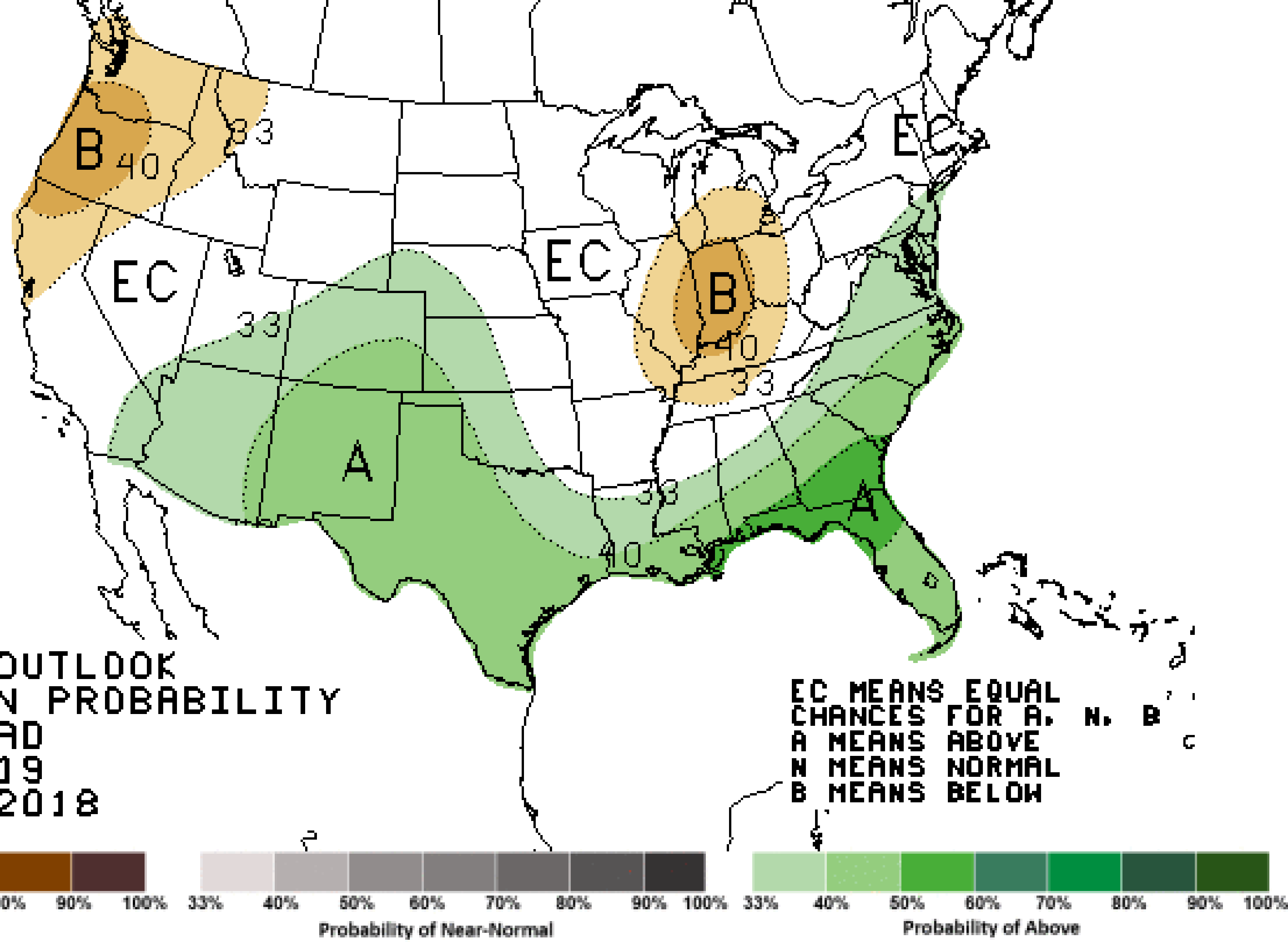
Duchesne & Green River Basins   January 1, 2019   Provo & Jordan River Basins



A
A
EC
33
EC
B
33
A
THREE-MONTH OUllOOK
TEMPERATURE PROBABILI1Y
0.5 MONTH LEAD
VALID JrM 2019
MADE 20 DEC 2018
EC t1EANS EQUAL
CHANCES rOA At Nt a
A NCANS ABOVE
N MCANS NORMAL
B MCANS BELOH
3% 40% 50% 60% 70% 80% 90% 100%
Probability of Below
40% 50% 60% 70% 80% 90% 100%
Probability of Near-Norma
40% 50% 60% 70%
Probability of Above

"A weak El Nino is forecast for this winter and may augment Utah's precipitation totals--particularly for southern Utah."

NRCS's Utah Climate and Water Report, January 1, 2019



Back to Top

Drip Irrigation Systems: Design and Installation

Highlighting the benefits of drip irrigation and proper irrigation equipment alternatives for urban, small farms, & home gardens and a demonstration of how to install and operate a drip system.

Dale Allred
Global Water and Land Use Specialist
AES International PLLC
dale5790@gmail.com

Dale Allred is a Professional Civil & Environmental Water Engineer with a Master's Degree in Irrigation Engineering from Utah State University. Mr. Allred has 40 years of experience in irrigation and agricultural development in the United States, Latin America, and Europe.
After installing the first ever drip system for vegetables in Central Mexico in 1982, Allred's ingenuity and understanding of drip irrigation's role in integrated farming transformed Mexico's vegetable industry into the most productive in the world.
Mr. Allred currently works with Bennett & Bennett Irrigation in Lemoore, CA on strategic agricultural initiatives. Mr. Allred also consults with growers and sells drip equipment locally and internationally. Mr. Allred is also a farmer, growing vegetables for local restaurants and families in Utah.

Back to Top

Drip Irrigation Systems: Scheduling, Operation, and Maintenance

The water track covers diverse water topics this year including water rights, water quality for irrigation, water conservation, and drip irrigation design, installation, and operation. The information will provide an understanding of water from a state perspective down to your farm. While on-farm irrigation emphasize will be on drip our experts can respond to other irrigation questions.

Niel Allen
Irrigation Extension Specialist
Utah State University
n.allen@usu.edu

Dr. L. Niel Allen is the Extension Irrigation Specialist for Utah. He grew up on an irrigated farm in Cove, Utah and received his BS and MS degrees from Utah State University in Agriculture and Irrigation Engineering and a PhD in Civil Engineering from the University of Idaho. He has over 35years of professional experience including design and installation of irrigation systems, consulting with irrigation districts, water rights, irrigation research, and extension.

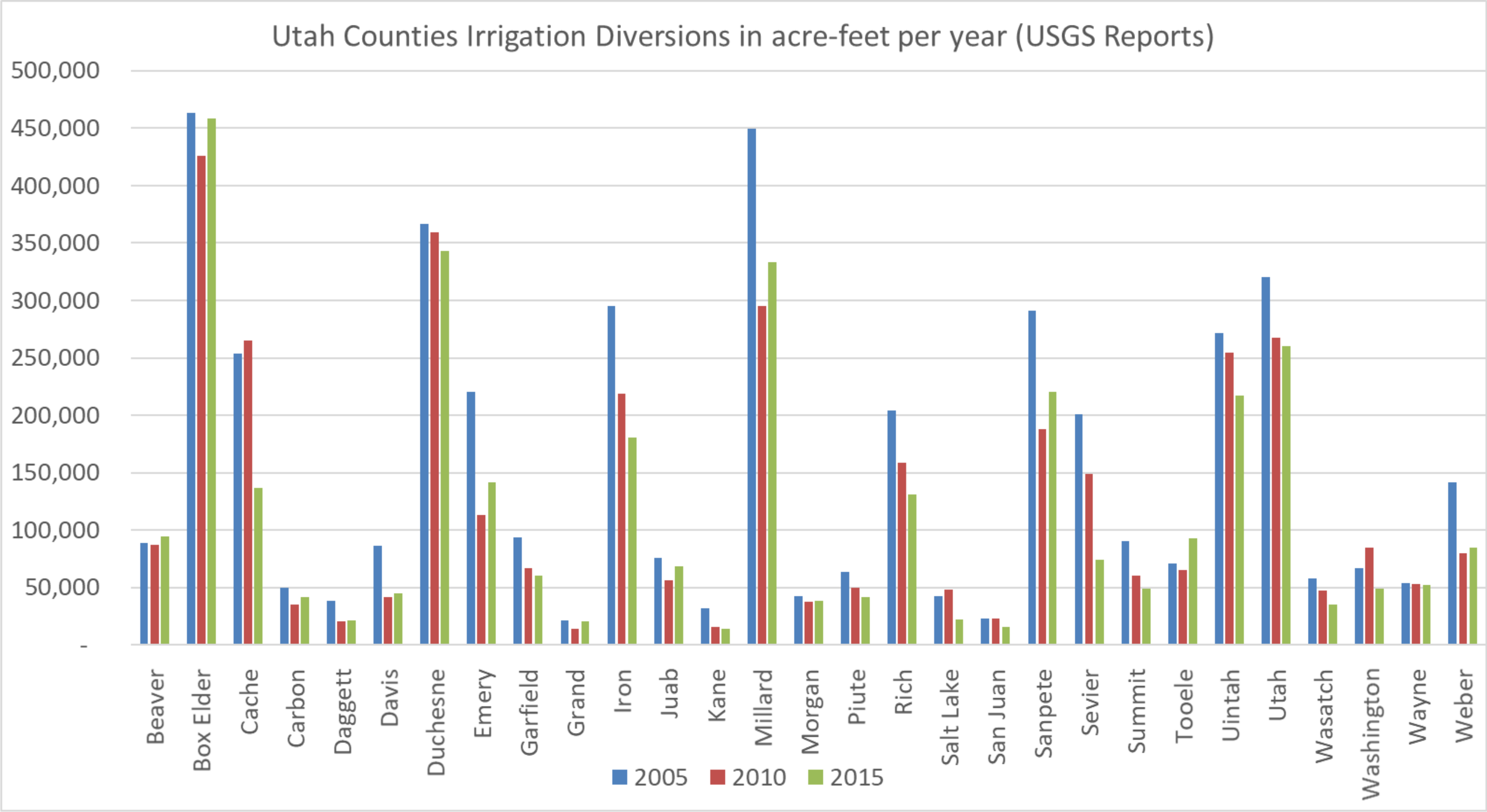
Drip Irrigation Systems: Scheduling, Operation, and Maintenance

L. Niel Allen
n.allen@usu.edu
http://extension.usu.edu/irrigation/

Urban and Small Farm Workshop
February 21, 2019

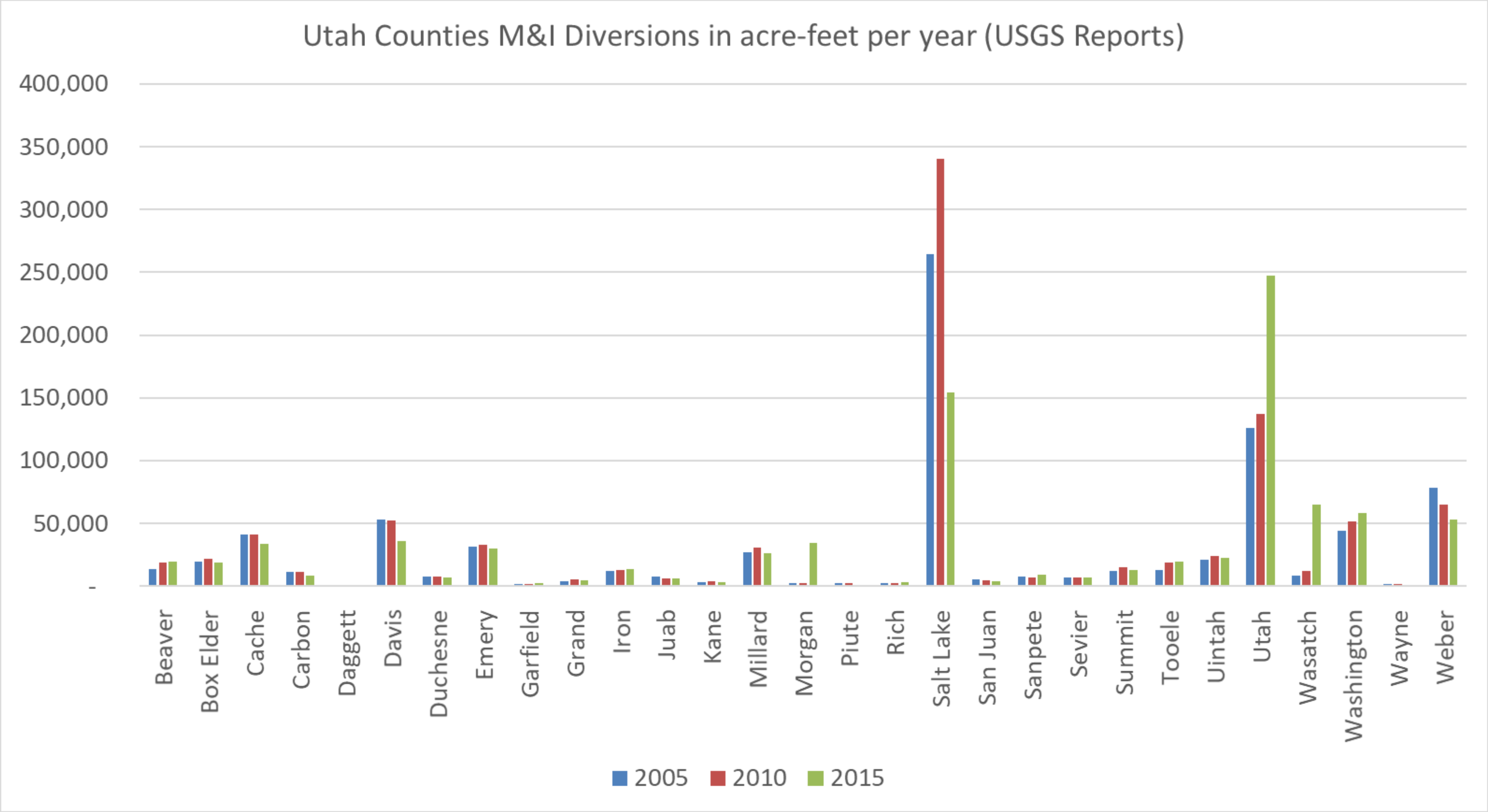
EXTENSION
UtahStateUniversity

EXTENSION.USU.EDU



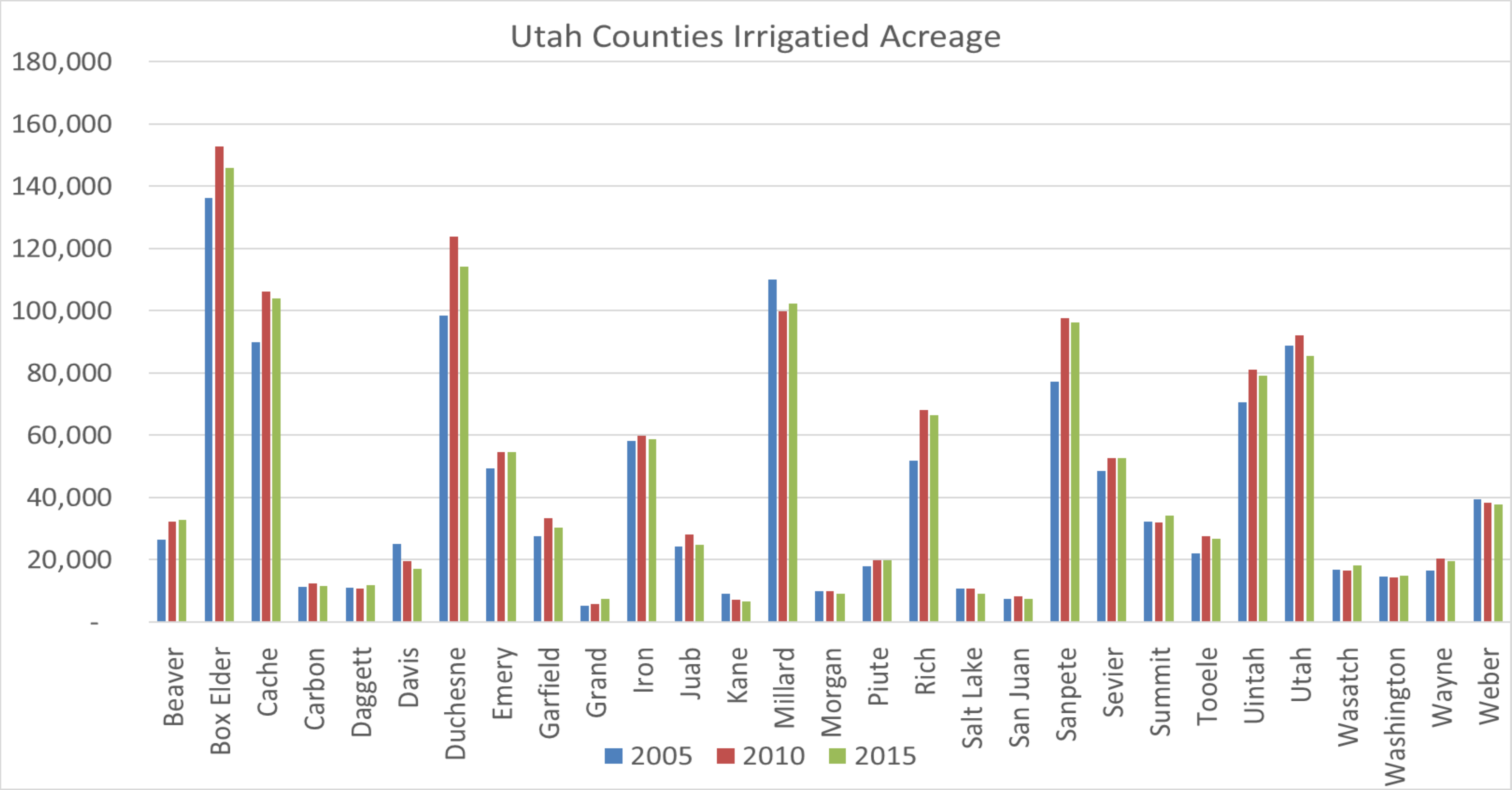
EXTENSION.USU.EDU

EXTENSION UtahStateUniversity



EXTENSION.USU.EDU

EXTENSION UtahStateUniversity



EXTENSION.USU.EDU

EXTENSION UtahStateUniversity

Summary of USGS Water Use Reports for Utah

State Totals	Total Water withdrawal	Non-Agricultural			Crop Irrigation			
Year	Ac-ft/yr	Population	Ac-ft/yr	gpcd**	acres	Ac-ft/yr	Ac-ft/ac	% of Total
2005	5,400,632	2,547,389	924,517	324	1,206,600	4,476,115	3.71	83%
2010	4,629,262	2,763,885	1,045,720	338	1,335,860	3,583,542	2.68	77%
2015	4,340,609	2,995,919	994,757	296	1,298,610	3,345,852	2.58	77%

** (gpcd is gallons per capita per day) Includes all public supply water (municipal, industry, residential, etc.) and golf courses.

Irrigation Scheduling

When to irrigate and

How much water to apply

OBJECTIVE:

Apply only the water needed met crop water use and to refill the root zone

Information Needs

Plant or crop water use

Crop root zone and readily available water

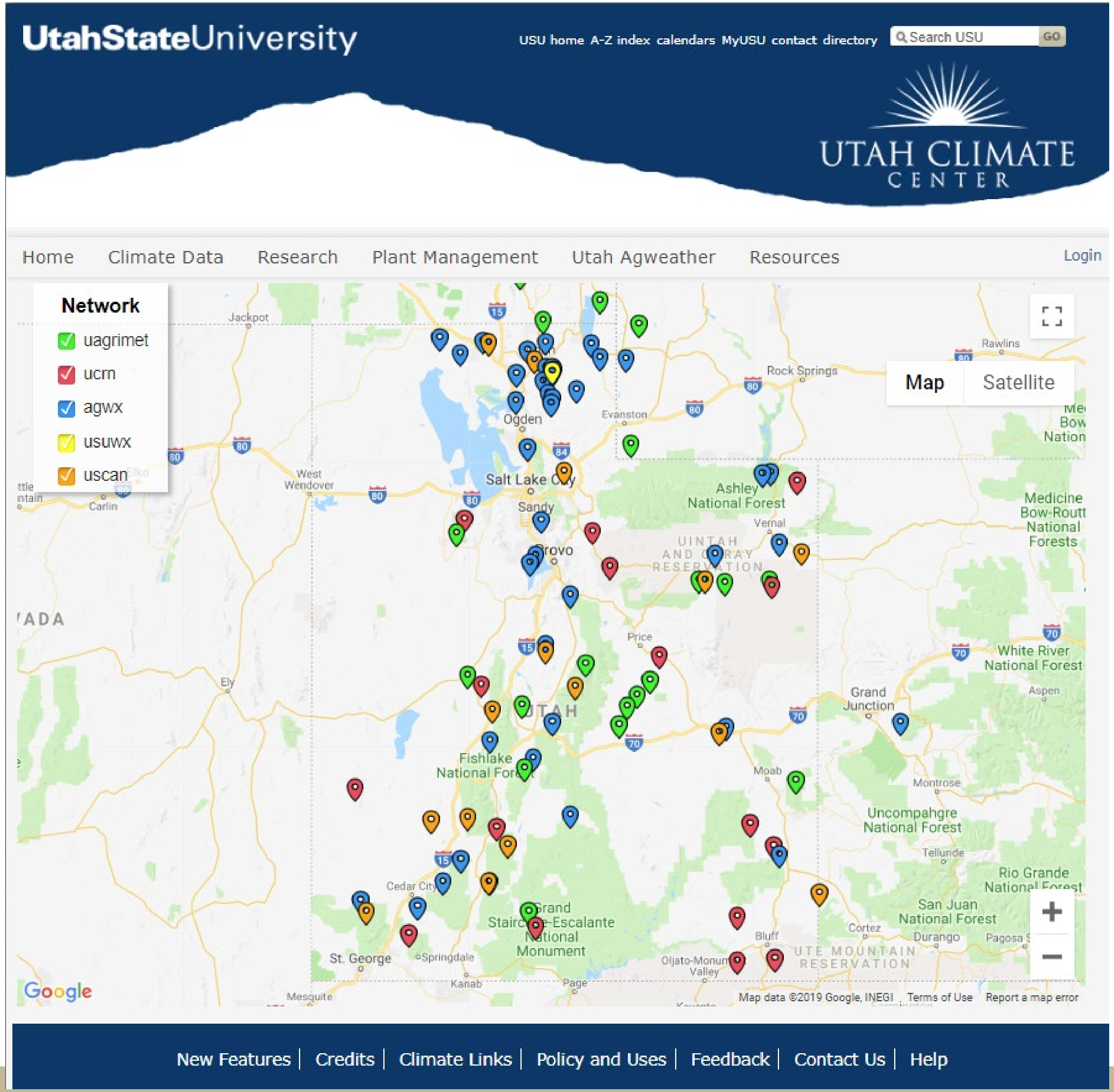
Irrigation system capabilities

Plant or Crop Water Use

- Evaporation and transpiration
  - Estimated from available energy and climate conditions (solar radiation, temperature, wind, humidity)
- Reference crop (alfalfa or grass)
- Adjustment for specific crops based on crop growth or vegetative stage (crop coefficient)

Weather Station at Murray, Utah

Rain,
wind speed and direction,
temperature,
solar radiation,
humidity,
soil temperature



Utah Climate Center

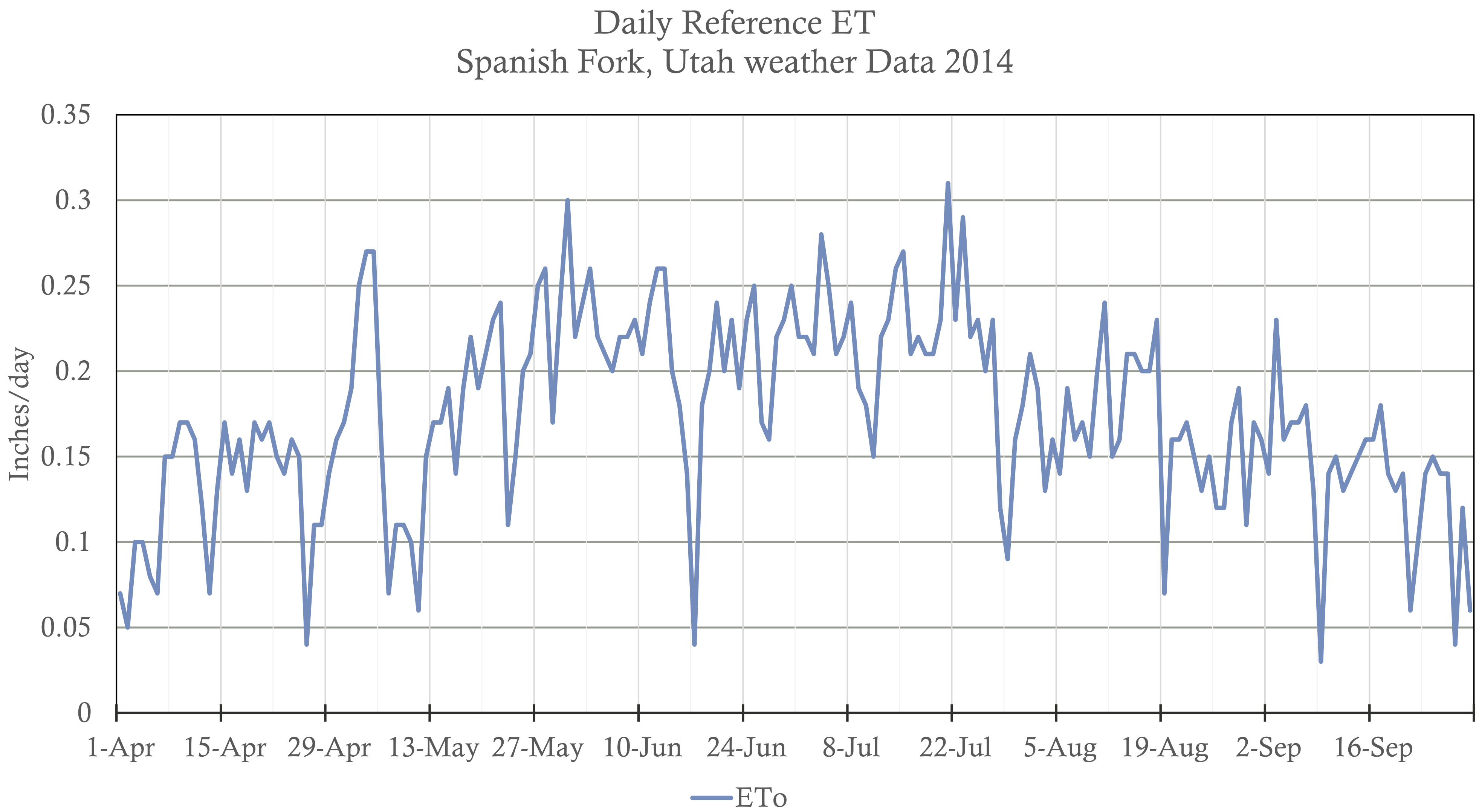
https://climate.usu.edu

Utah Agweather

click on site

view quick data or download data

Reference ET

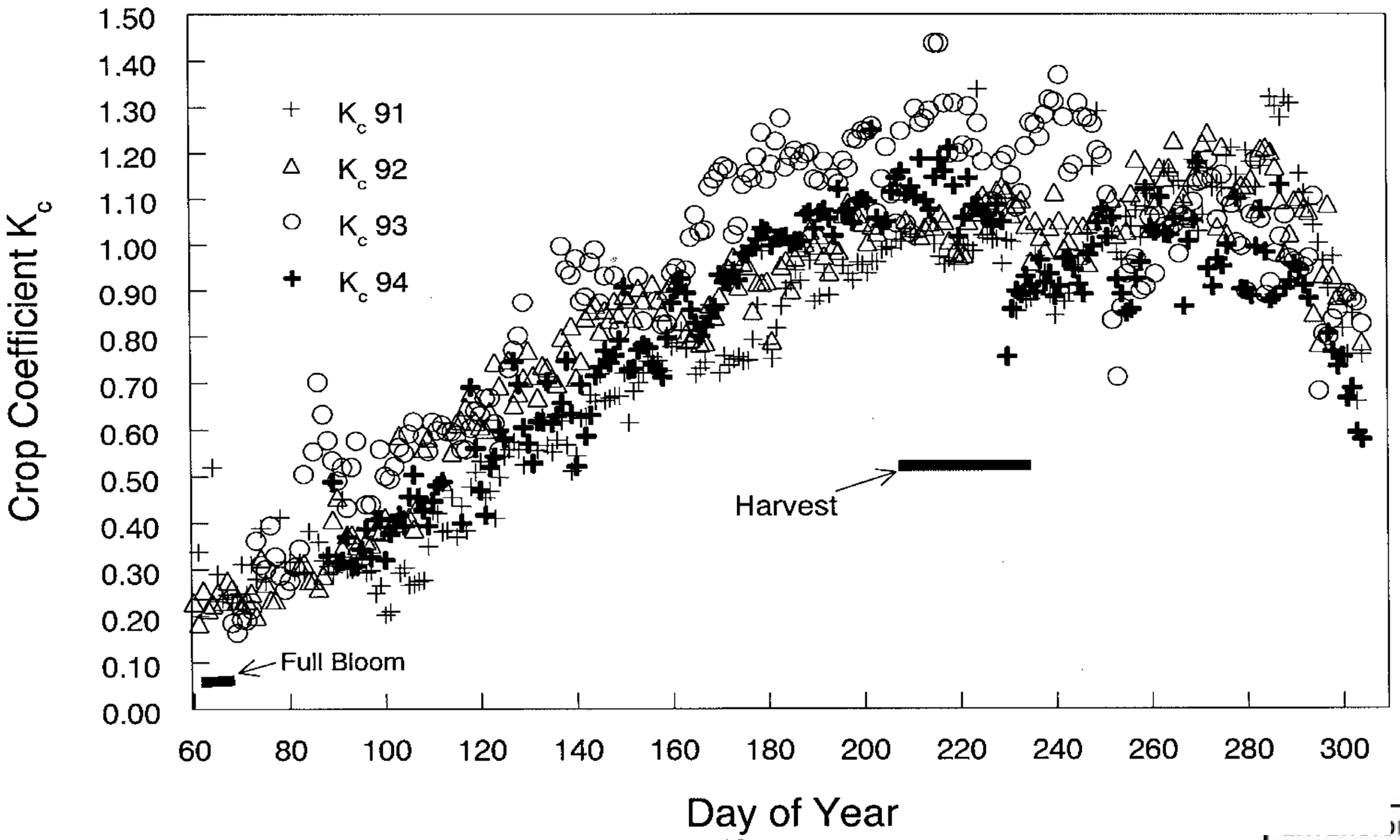


Water use by drip-irrigated late-season peaches

J. E. Ayars, R. S. Johnson, C. J. Phene, T. J. Trout, D. A. Clark, R. M. Mead

Irrigation Science 22.3-4 (2003): 187-194.

Kc for Eto grass reference

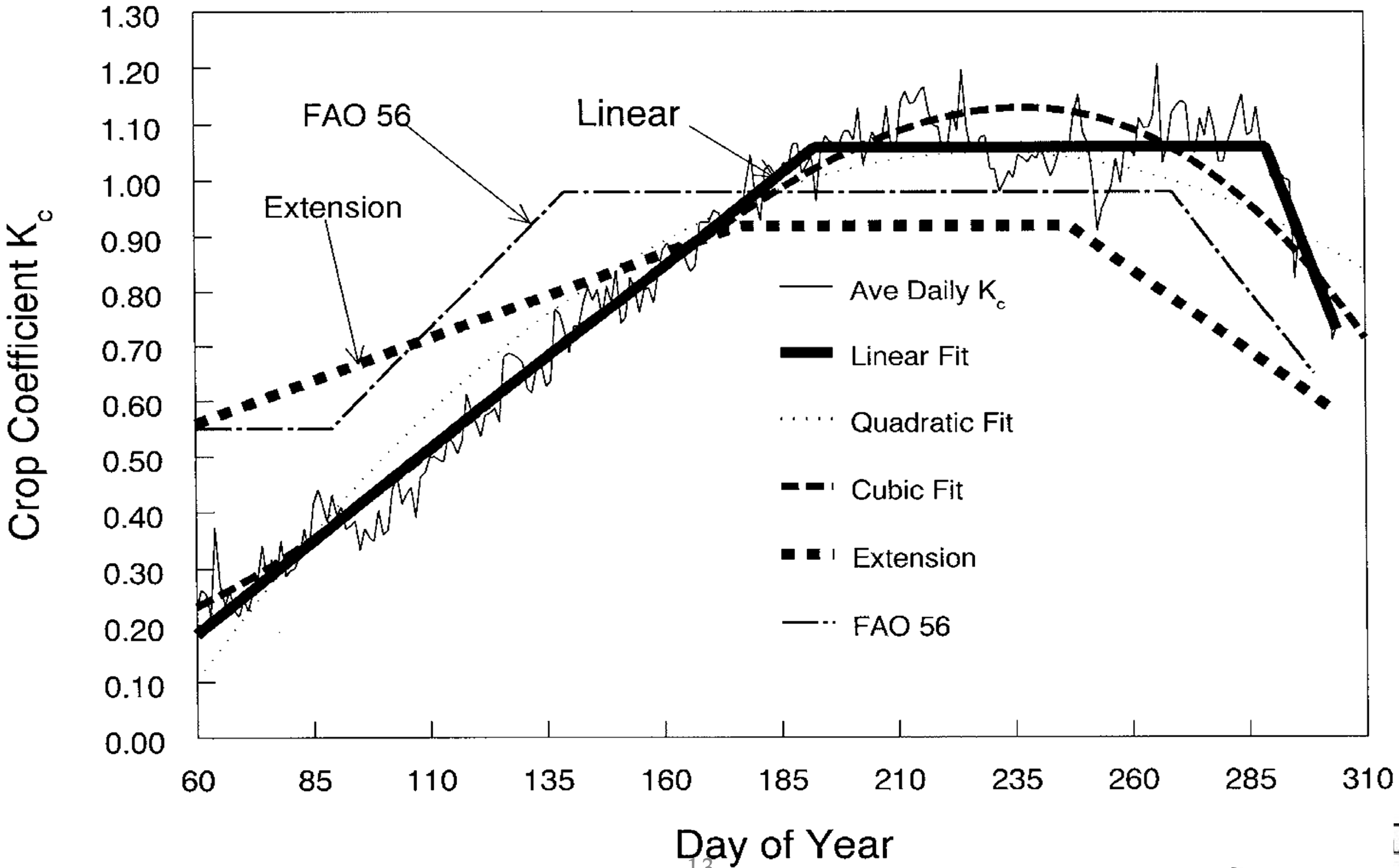


Water use by drip-irrigated late-season peaches

J. E. Ayars, R. S. Johnson, C. J. Phene, T. J. Trout, D. A. Clark, R. M. Mead

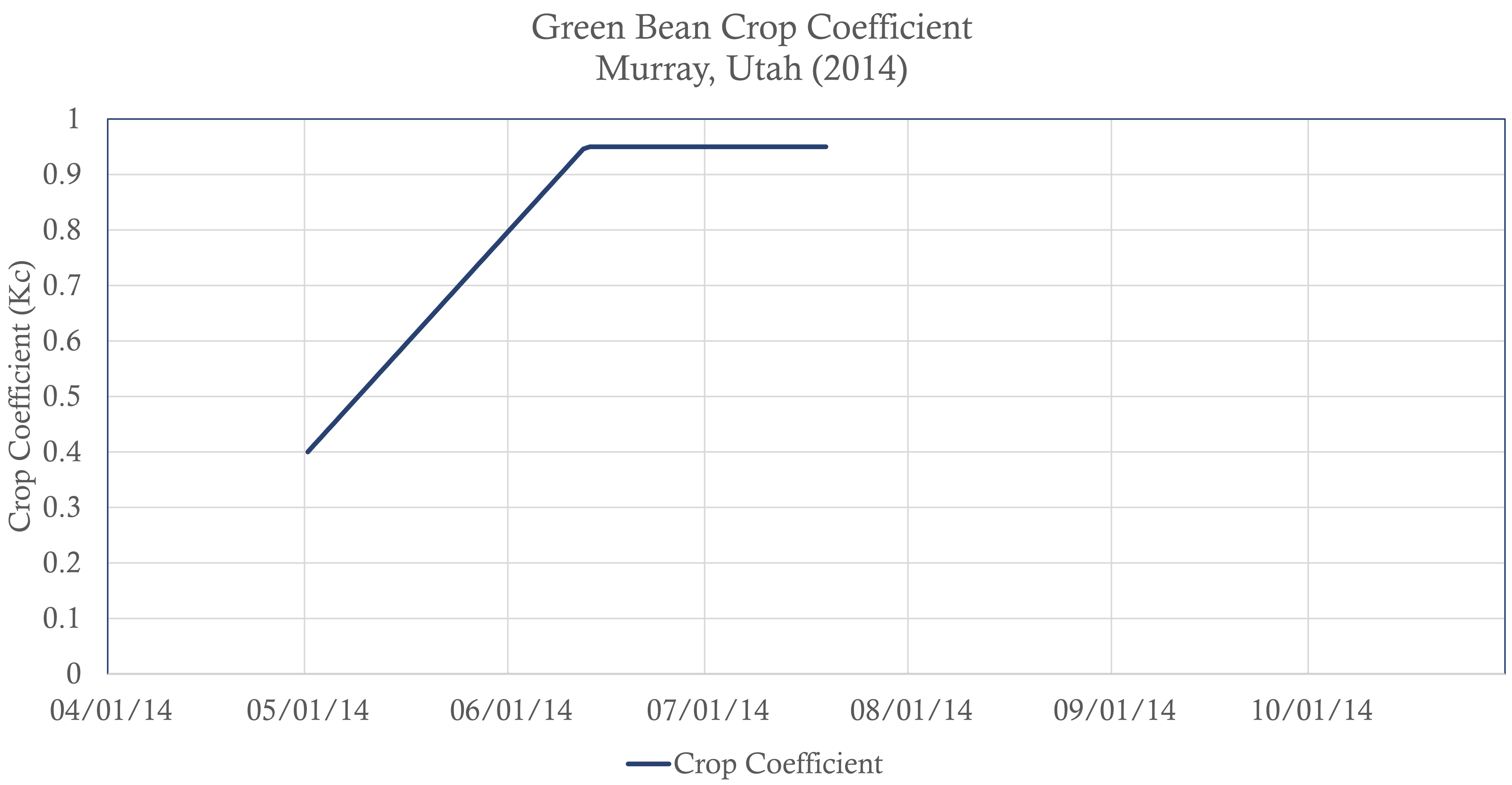
Irrigation Science 22.3-4 (2003): 187-194.

Kc for Eto (grass reference)

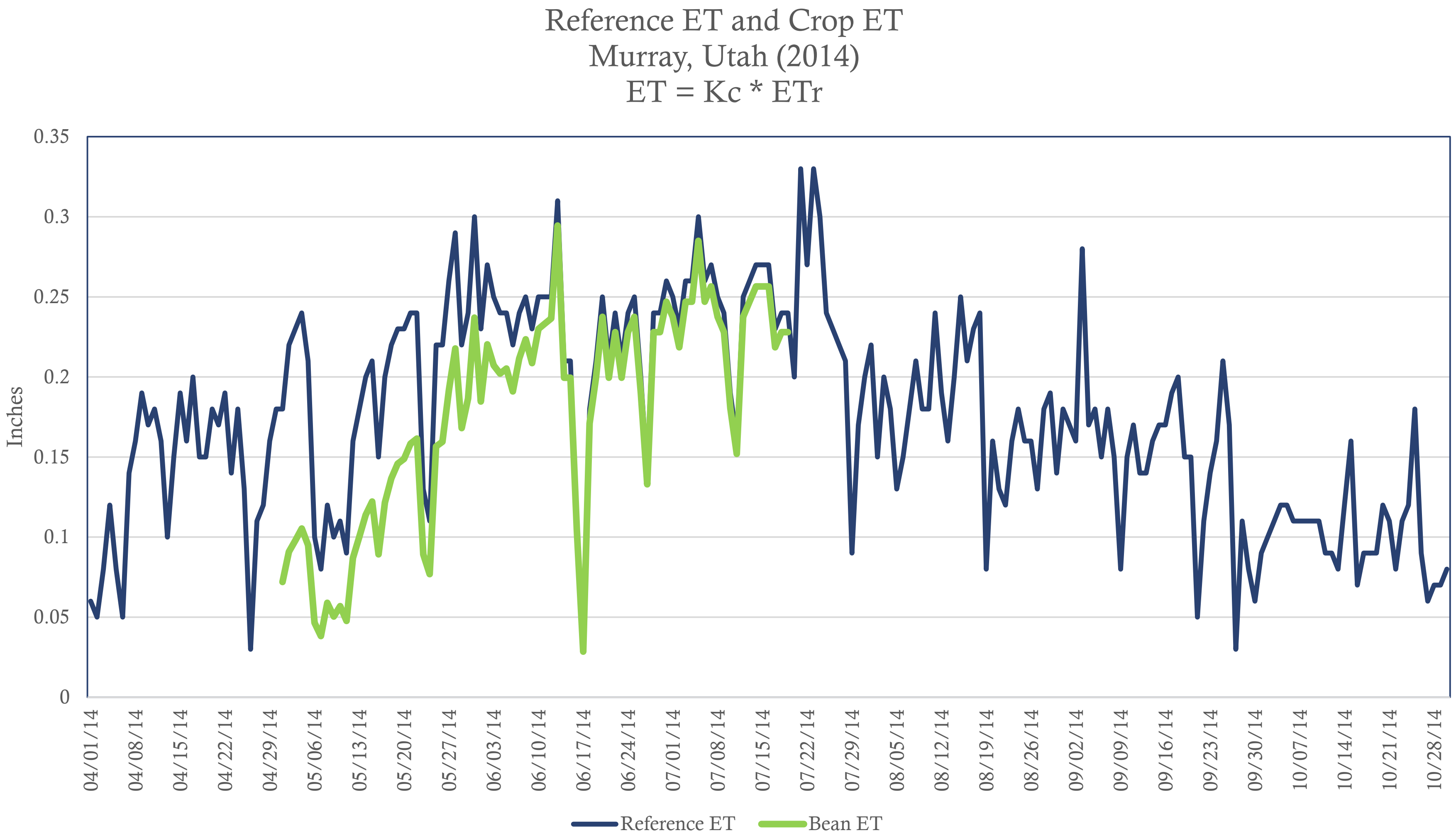


Example of Crop Coefficient
Estimated ET crop = Kc * ETr

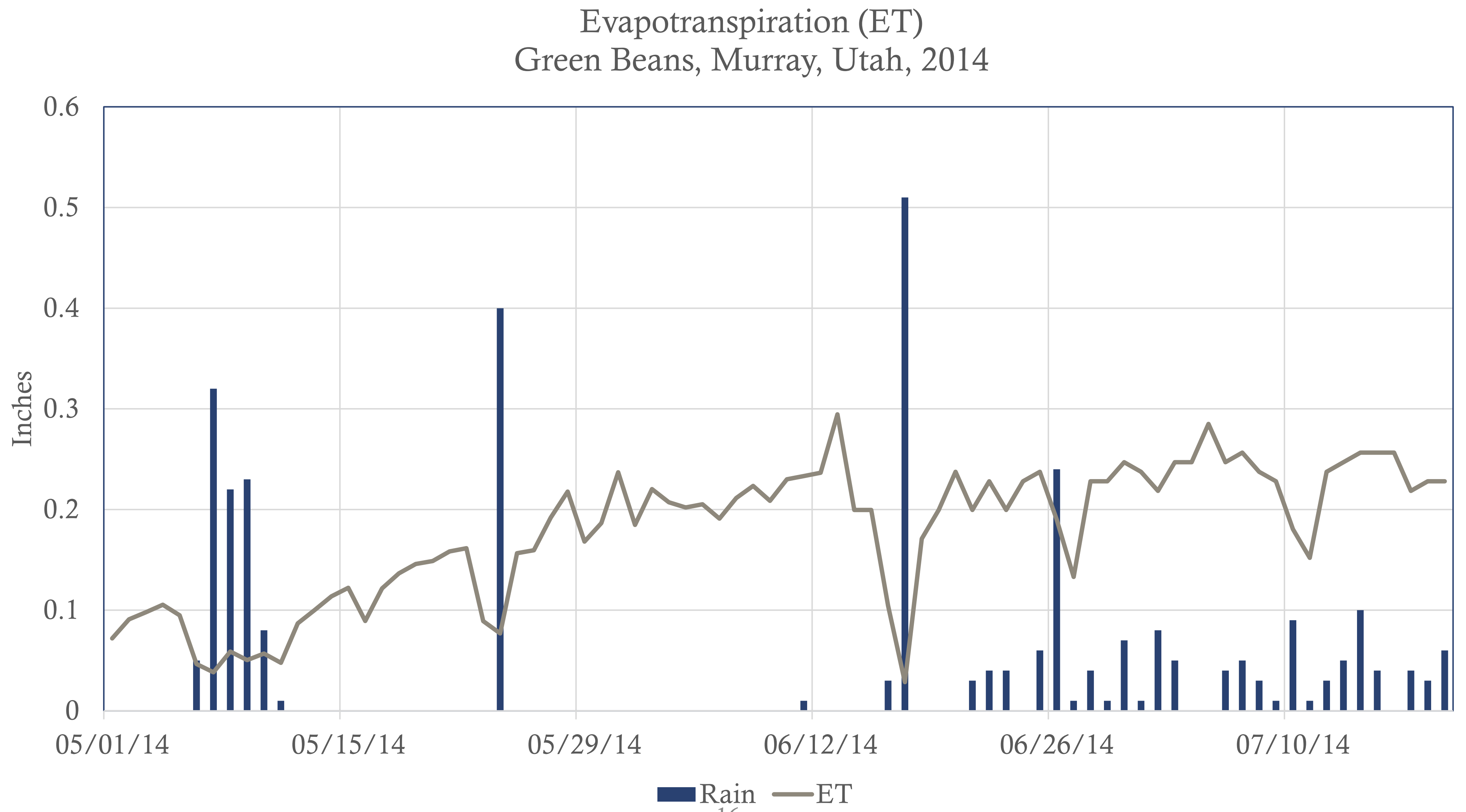
http://www.usbr.gov/pn/agrimet/cropcurves/crop_curves.html



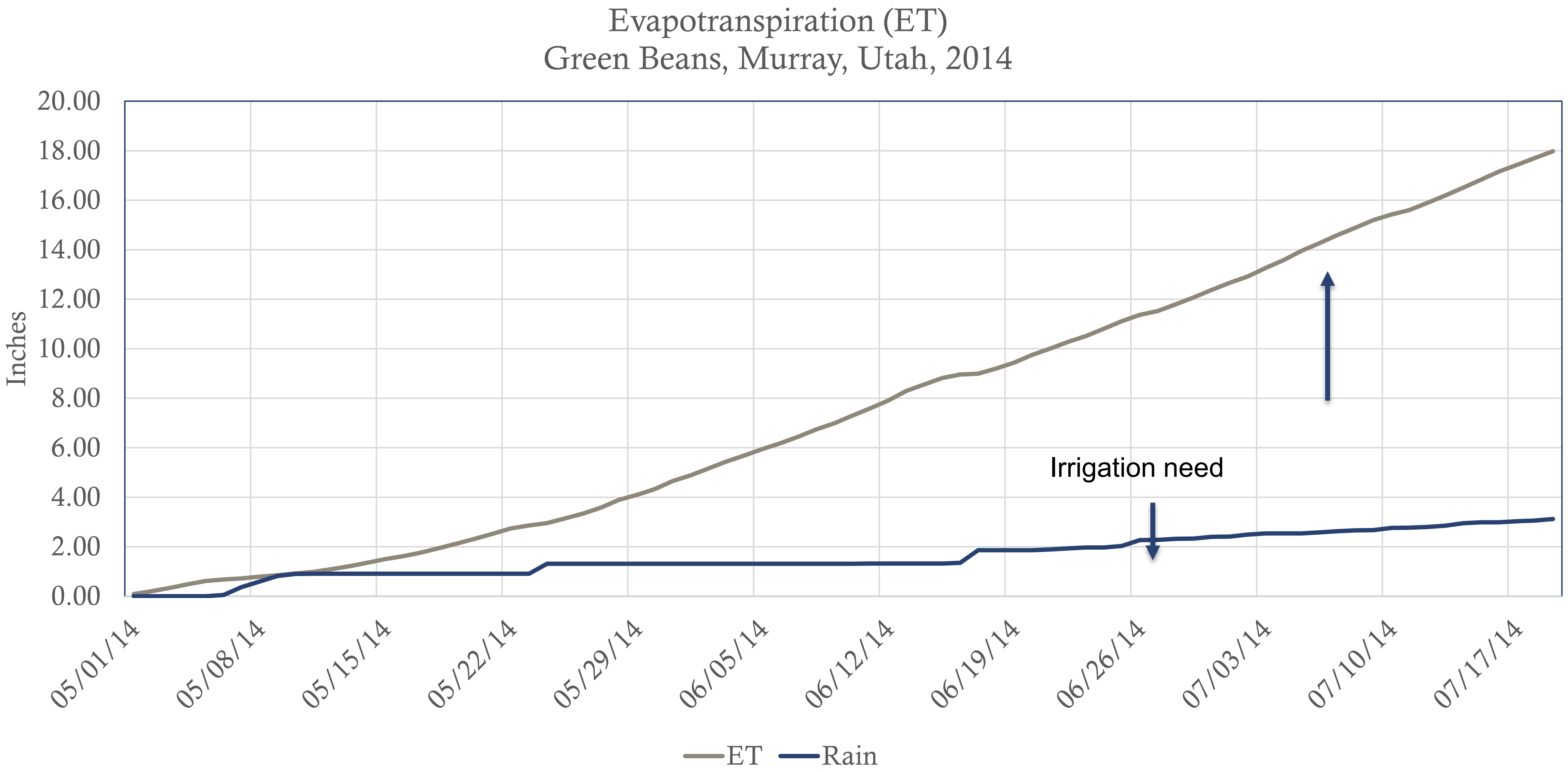
Reference ET and Bean ET



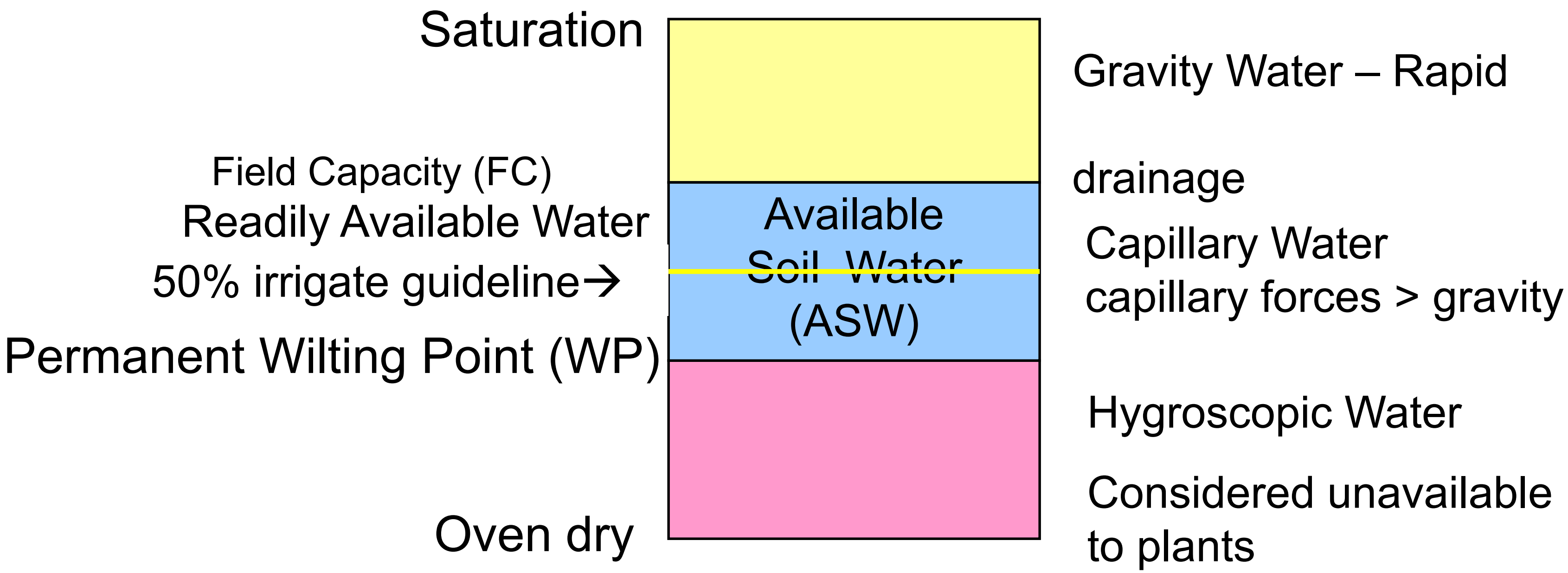
Example of Estimated ET
(also shows precipitation)



Cumulative ET and Rain



Soil Water

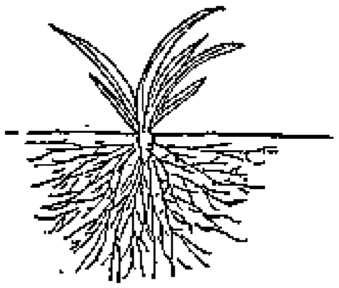

Saturation
Field Capacity (FC)
Readily Available Water
50% irrigate guideline→
Permanent Wilting Point (WP)
Oven dry
Available Soil Water (ASW)
Gravity Water – Rapid drainage
Capillary Water
capillary forces > gravity
Hygroscopic Water
Considered unavailable to plants

Available Soil Water

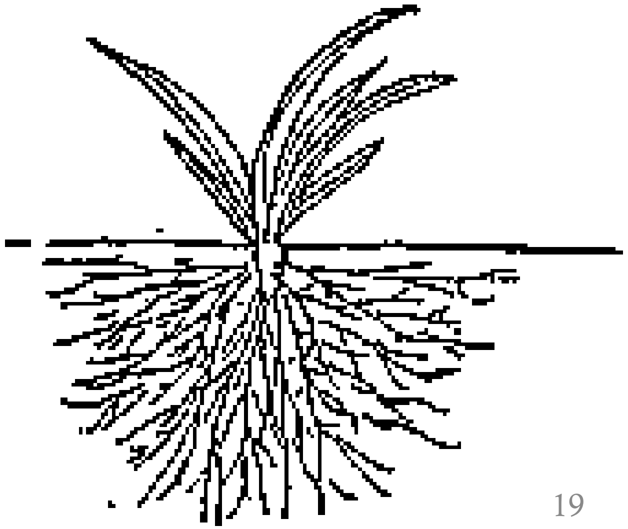
Using example of Beans

- Rooting Depth of 1.5 to 2 feet
- Readily Available Water (about 1 inch per foot)
- Readily Available Water is 1.5 to 2 inches (more is available but may cause stress)

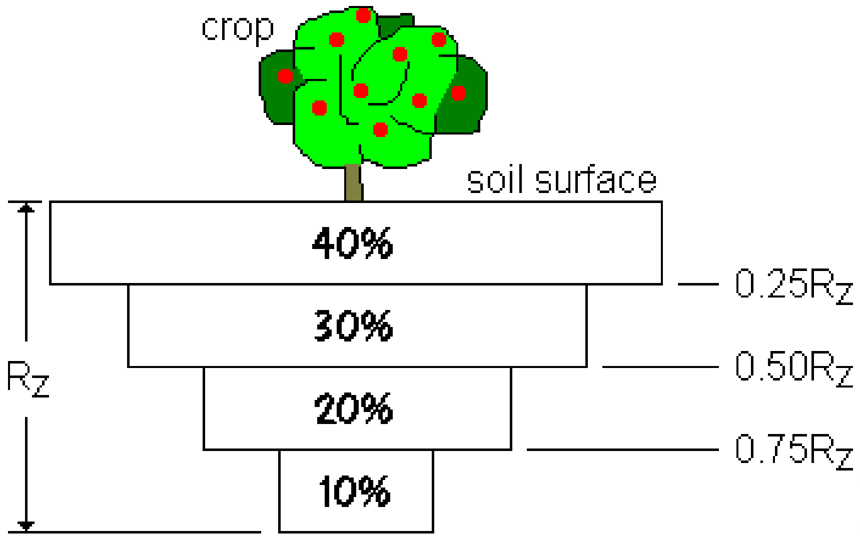
Young Plant



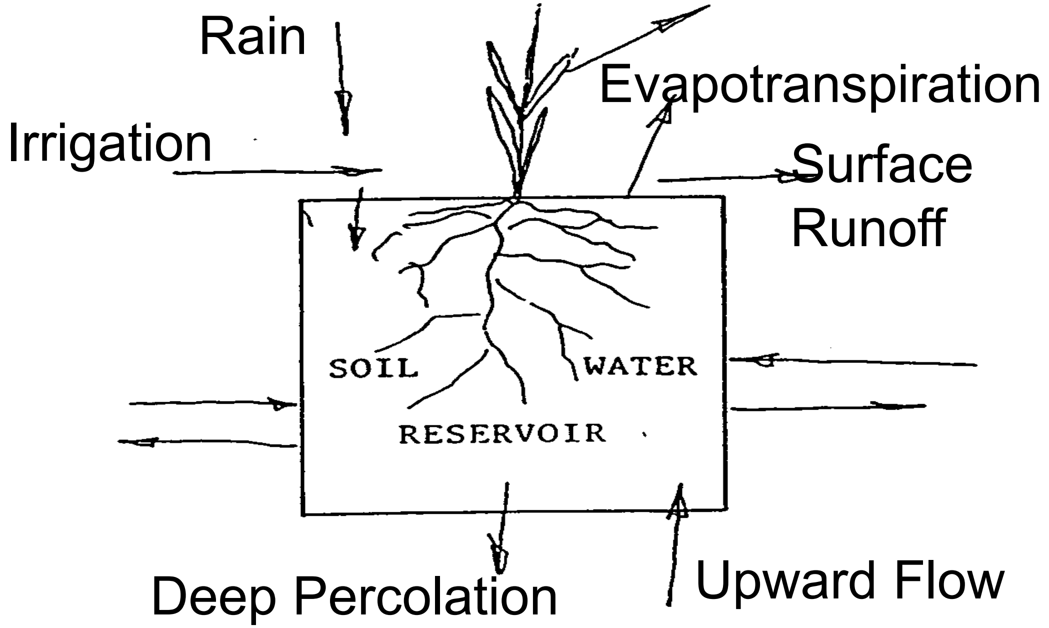
More Mature Plant



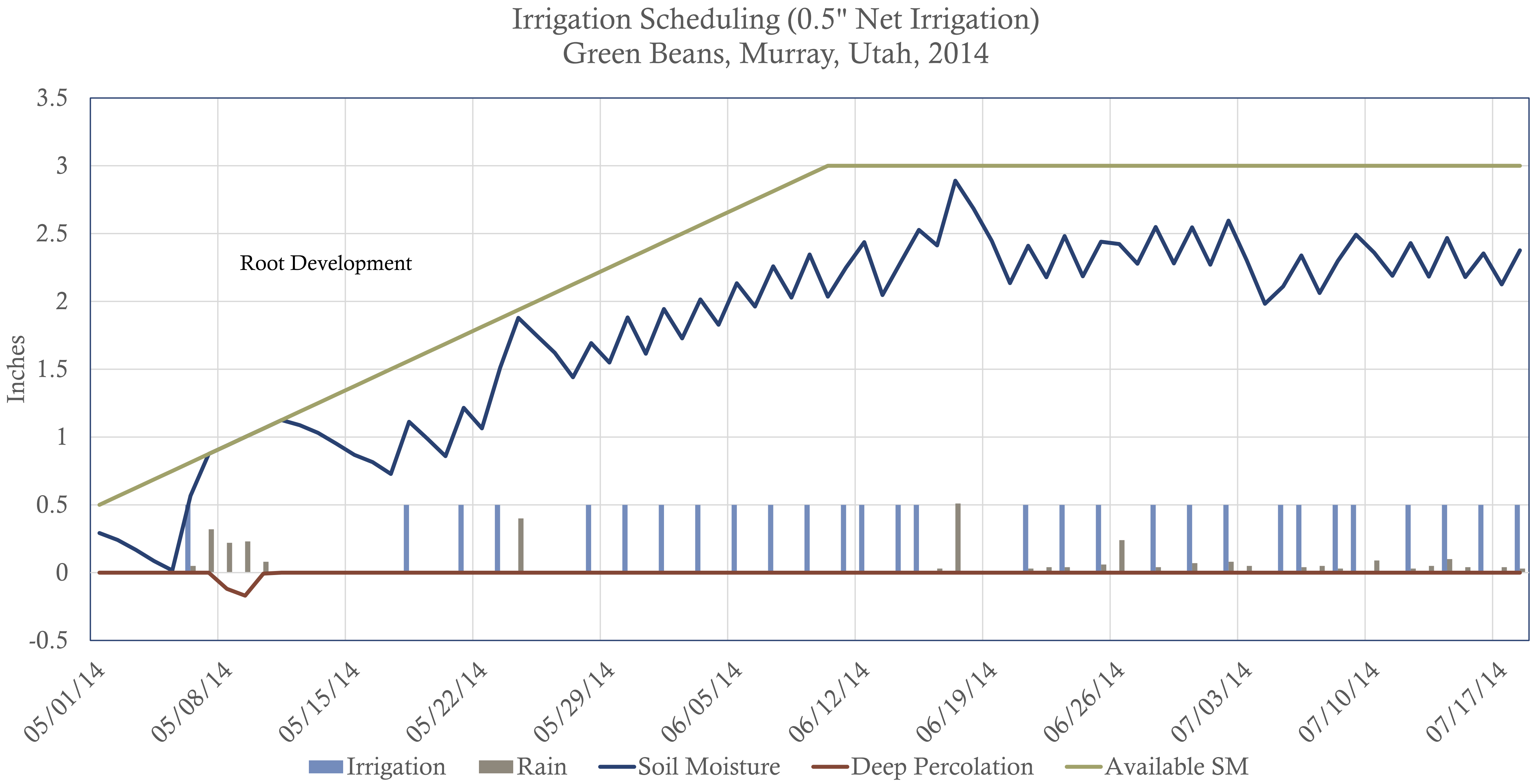
Typical Water Extraction Pattern



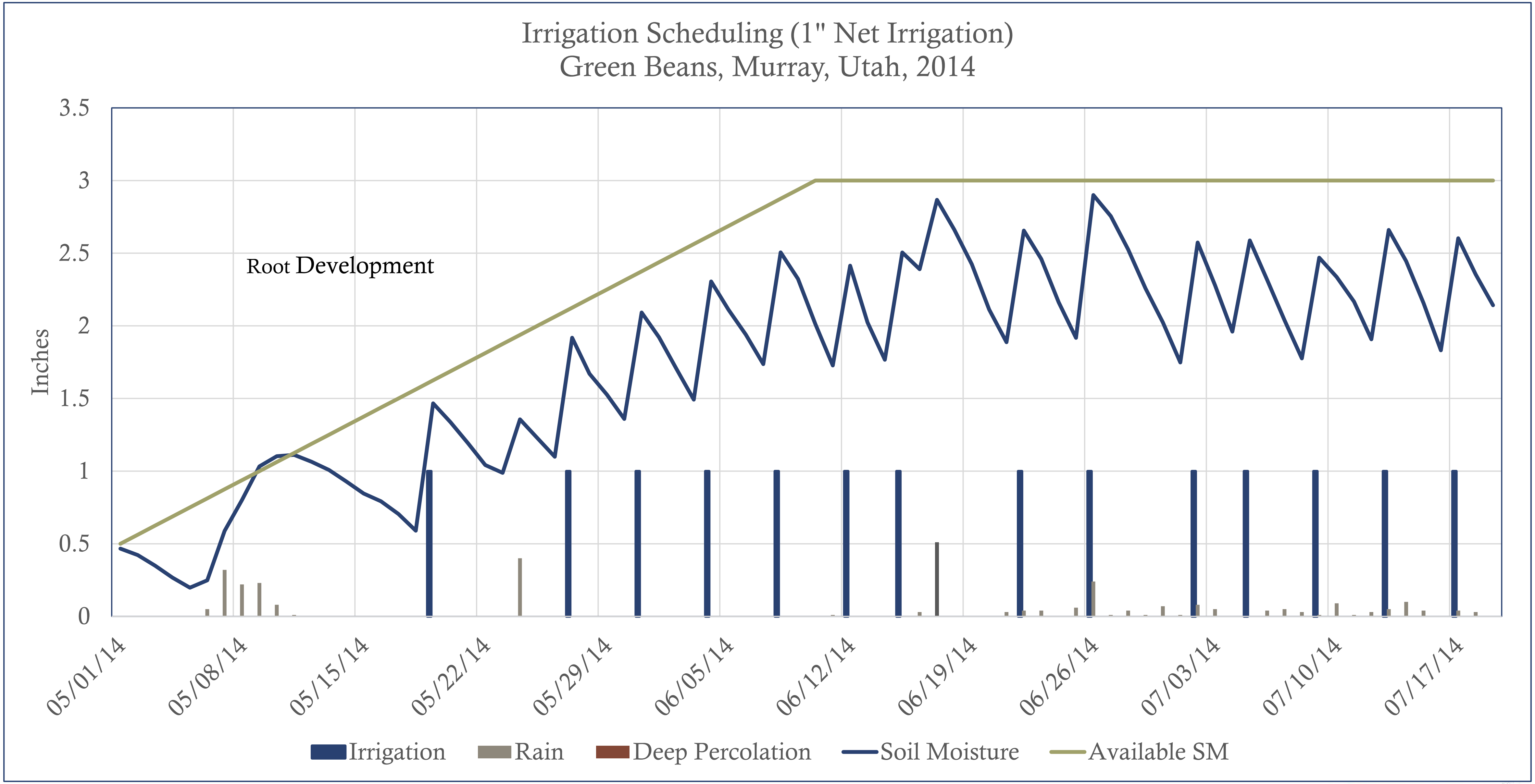
Soil Water Budget



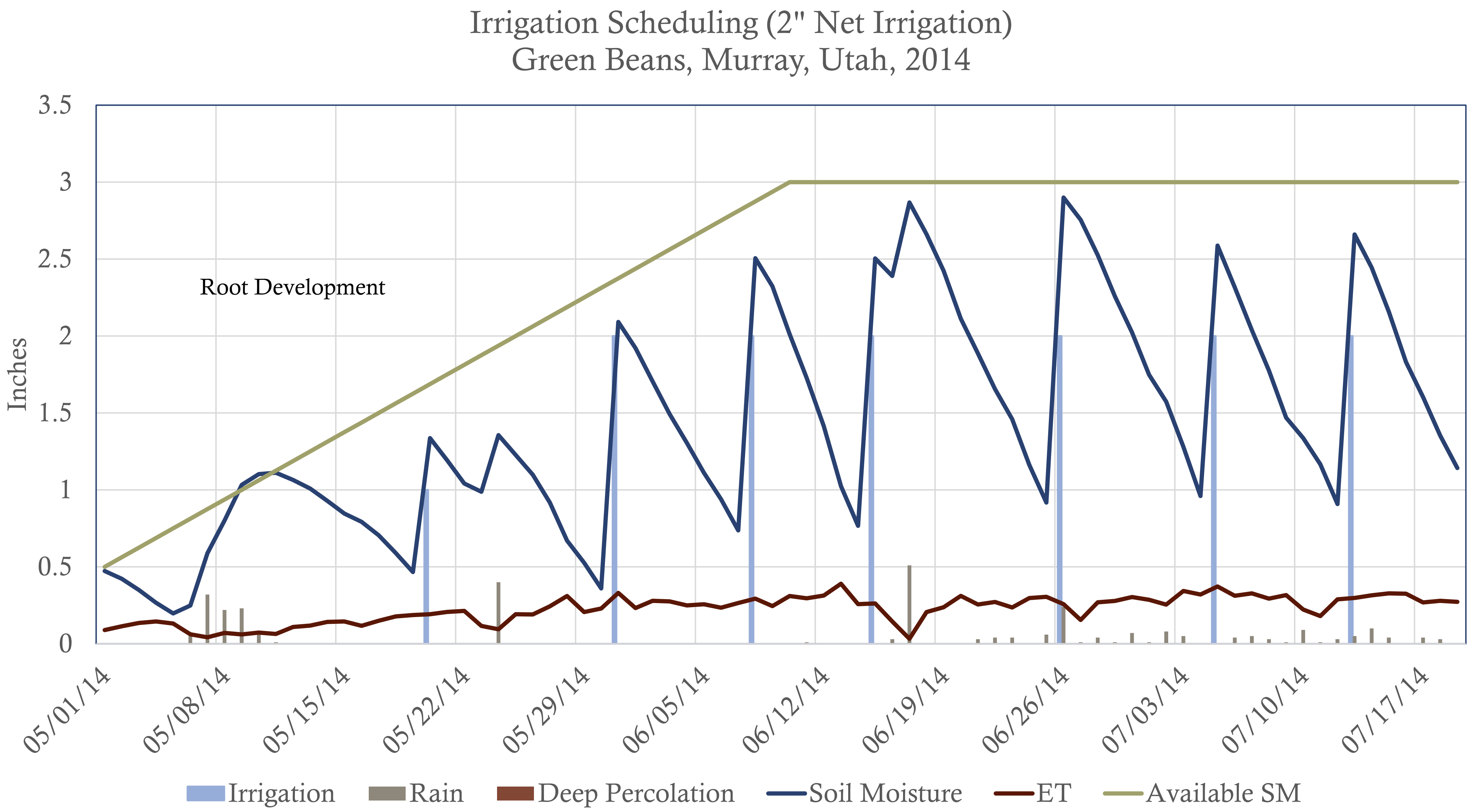
Irrigation Scheduling (0.5" Net Irrigation)



Irrigation Scheduling (1" Net Irrigation)



Irrigation Scheduling (2" Net Irrigation)



How Much and When to Irrigation

Water holding capacity of soil

How much water is in the soil

- Feel the soil
- Weigh and dry the soil (need bulk density of soil)
- Tensiometer
- Resistance blocks (WaterMark Sensors)
- To estimate matrix potential
- Other devices (probe)

Appearance of the plants

Quantity of water applied

Irrigation Interval – Pasture

Root Depth = 2.5 ft, Allowable Depletion = 50%,
Peak ET = 0.25 in/day

Soil Type	AWHC in/ft	Root Zone Available Soil water, inches	MAD (50%) refill (inches)	Maximum Irrigation Interval, days
Sand	0.6	1.5	0.75	3
Fine sandy loam	1.0	2.5	1.25	5
Loam	2.0	5.0	2.5	10

Soil Water by Feel

**Sandy clay loam,
loam, and
Silt loam soils**

25-50 percent available
1.6-0.8 in./ft. depleted

50-75 percent available
1.1-0.4 in./ft. depleted

75-100 percent available
0.5-0.0 in./ft. depleted

Soil Water by Feel

Sandy loam and
Fine sandy loam soils

25-50 percent available
1.3-0.7 in./ft. depleted

50-75 percent available
0.9-0.3 in./ft. depleted

75-100 percent available
0.4-0.0 in./ft. depleted

Irrigation Application Rates

Conversions
1 cfs = 448.8 gpm
1 gpm = 60 gph
1 acre = 43,560 feet^2

In./hr. = cubic feet per second (cfs) / acres
Example: 4 cfs / 5 acres = 0.8 in/hr

Sprinkler Irrigation (flow is usually in gallons per minute)
In./hr.=96.24 *gallons per minute(gpm)/area (ft^2)
Example: 96.24*7 gpm / (40 ft*60 ft) = 0.28 in/hr

Drip Irrigation (flow per emitter is usually in gallons per hour)
In./hr.=1.6 *gallons per hour(gph)/emitter spacing (ft^2)
Example: 1.6*.5 gph / (1 ft * 2.5 ft) = 0.32 in/hr

One gallon in one square foot would be 1.6 inches deep

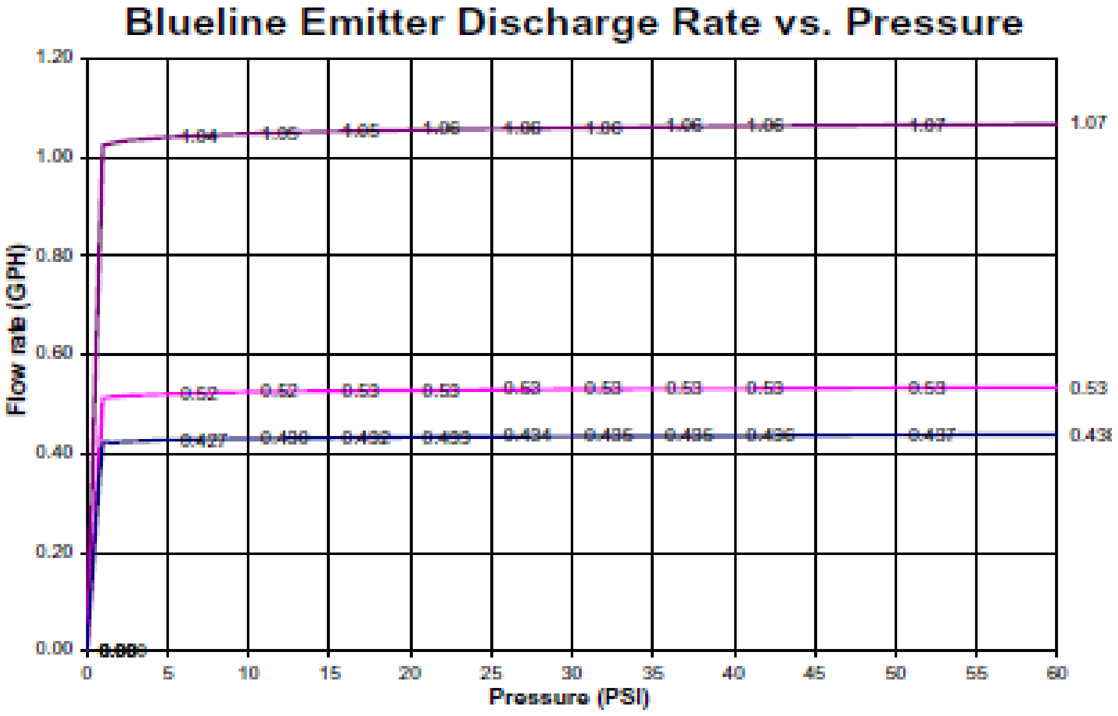
Pressure Compensating Emitters

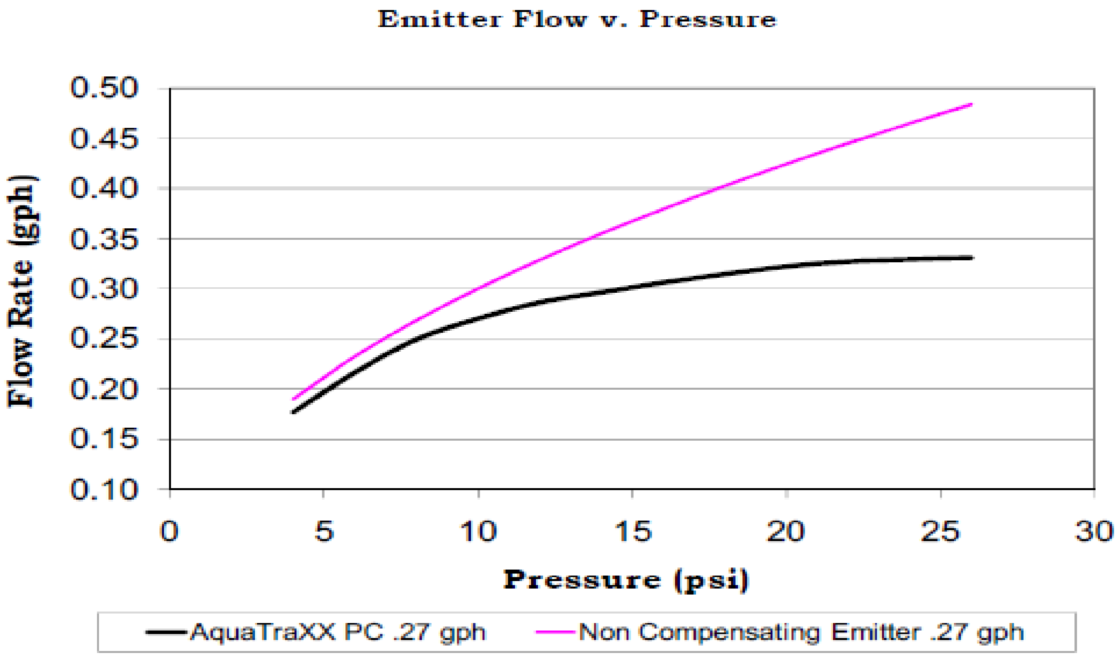
In./hr.=1.6 *gallons per hour(gph)/emitter spacing (ft^2)

spacing is row spacing time emitter spacing

Drip tubing

Drip tape





Examples from Toro Irrigation literature

How many feet of tubing can I operate with my water supply? Can be designed to accommodate water supply. Pressure compensating emitters best for long lines. A typical outdoor faucet can provide about 5 - 7 gallons per minute.

Drip Tubing/Tape for various water supplies (feet)		Drip Tubing/Line/Tape (gallon per minute per 100 feet)							
		0.17	0.33	0.50	0.67	0.83	1.00	1.17	1.33
		Drip Tubing/Line/Tape (gallon per hour per 100 feet)							
		10	20	30	40	50	60	70	80
Water Supply Flow (gallons per minute)	5	3000	1500	1000	750	600	500	429	375
	10	6000	3000	2000	1500	1200	1000	857	750
	15	9000	4500	3000	2250	1800	1500	1286	1125
	20	12000	6000	4000	3000	2400	2000	1714	1500
	25	15000	7500	5000	3750	3000	2500	2143	1875
	30	18000	9000	6000	4500	3600	3000	2571	2250
	35	21000	10500	7000	5250	4200	3500	3000	2625
	40	24000	12000	8000	6000	4800	4000	3429	3000

How much time should I run an irrigation set?

In./hr.=1.6 *gallons per hour(gph)/emitter spacing (ft^2)

Efficiencies are 85 to 95 percent

		Drip Tubing/Line/Tape (gallon per minute per 100 feet)							
		0.17	0.33	0.50	0.67	0.83	1.00	1.17	1.33
		Drip Tubing/Line/Tape (gallon per hour per 100 feet)							
		10	20	30	40	50	60	70	80
Line Spacing (inches)	6	**0.32 in/hr**	**0.64**	**0.96**	**1.28**	**1.60**	**1.92**	**2.25**	**2.57 in/hr**
	12	**0.16**	**0.32**	**0.48**	**0.64**	**0.80**	**0.96**	**1.12**	**1.28**
	18	**0.11**	**0.21**	**0.32**	**0.43**	**0.53**	**0.64**	**0.75**	**0.86**
	24	**0.08**	**0.16**	**0.24**	**0.32**	**0.40**	**0.48**	**0.56**	**0.64**
	30	**0.06**	**0.13**	**0.19**	**0.26**	**0.32**	**0.38**	**0.45**	**0.51**
	36	**0.05**	**0.11**	**0.16**	**0.21**	**0.27**	**0.32**	**0.37**	**0.43**
	42	**0.05**	**0.09**	**0.14**	**0.18**	**0.23**	**0.27**	**0.32**	**0.37**
	48	**0.04**	**0.08**	**0.12**	**0.16**	**0.20**	**0.24**	**0.28**	**0.32**
	60	**0.03**	**0.06**	**0.10**	**0.13**	**0.16**	**0.19**	**0.22**	**0.26**
	66	**0.03 in/hr**	**0.06**	**0.09**	**0.12**	**0.15**	**0.17**	**0.20**	**0.23 in/hr**

Drip Flow Rates

Flow Rates

Product	Part Number	Individual Emitter Flow Rate GPH@ 10 psi	Spacing inches	Q-100 GPM per 100 ft. @ 10 psi
0.20 GPH @ 10 PSI				
	EAPXxx0667	0.20 gph	6"	0.67
	EAPXxx0850	0.20 gph	8"	0.50
	EAPXxx1234	0.20 gph	12"	0.34
	EAPXxx1625	0.20 gph	16"	0.25
	EAPXxx1822	0.20 gph	18"	0.22
	EAPXxx2417	0.20 gph	24"	0.17
0.27 GPH @ 10 PSI				
	EAPXxx0690	0.27 gph	6"	0.90
	EAPXxx0867	0.27 gph	8"	0.67
	EAPXxx1245	0.27 gph	12"	0.45
	EAPXxx1634	0.27 gph	16"	0.34
	EAPXxx1830	0.27 gph	18"	0.30
	EAPXxx2422	0.27 gph	24"	0.22

Example from Toro Irrigation literature

3 to 5 gpm for 5/8” diameter
drip tape $0.04 to $0.12 per foot (8 to 15 mil)
drip tubing $0.20 to $0.30 per foot (45 mil)

Sprinkler Discharge Rates (approximate)

NOZZLE DISCHARGE – GALLONS PER MINUTE								
Nozzle Diameter in Inches								
p.s.i.	3/32	1/8	9/64	5/32	11/64	3/16	13/64	7/32
20	1.17	2.09	2.65	3.26	3.92	4.69	5.51	6.37
25	1.31	2.34	2.96	3.64	4.38	5.25	6.16	7.13
30	1.44	2.56	3.26	4.01	4.83	5.75	6.80	7.86
35	1.55	2.77	3.50	4.31	5.18	6.21	7.30	8.43
40	1.66	2.96	3.74	4.61	5.54	6.64	7.80	9.02
45	1.76	3.13	3.99	4.91	5.91	7.03	8.30	9.60
50	1.85	3.30	4.18	5.15	6.19	7.41	8.71	10.10
55	1.94	3.46	4.37	5.39	6.48	7.77	9.12	10.50
60	2.03	3.62	4.50	5.65	6.80	8.12	9.56	11.05
65	2.11	3.77	4.76	5.87	7.06	8.45	9.92	11.45
70	2.19	3.91	4.96	6.10	7.34	8.78	10.32	11.95
75	2.27	4.05	5.12	6.30	7.58	9.08	10.66	12.32
80	2.35	4.18	5.29	6.52	7.84	9.39	11.02	12.74
85	2.42	4.31	5.45	6.71	8.07	9.67	11.35	13.11
90	2.49	4.43	5.61	6.91	8.31	9.95	11.69	13.51
95	2.56	4.56	5.76	7.09	8.53	10.2	11.99	13.86
100	2.63	4.67	5.91	7.29	8.76	10.5	12.32	14.23

Sprinkler Application Rates

In./hr.=96.24 *gallons per minute(gpm)/area (ft^2)

Efficiencies (70-80 percent)

AVERAGE APPLICATION RATE – INCHES PER HOUR Gallons Per Minute From Each Sprinkler										
Spacing Feet	2	3	4	5	6	7	8	9	10	12
20x20	.48	.72	.96	1.20	1.44	1.70	1.93	2.16	2.40	
20x30	.32	.48	.64	.80	.96	1.12	1.28	1.43	1.60	1.93
30x40	.24	.36	.48	.60	.72	.84	.96	1.08	1.20	1.45
30x30	.21	.32	.43	.54	.64	.75	.88	.96	1.07	1.28
30x40	.16	.24	.32	.40	.48	.56	.64	.72	.80	.95
30x50	.13	.19	.25	.32	.38	.45	.51	.58	.64	.76
40x40	.12	.18	.24	.30	.36	.42	.48	.54	.60	.72
40x50	.10	.14	.19	.24	.29	.34	.38	.43	.48	.58
40x60		.12	.16	.20	.24	.28	.32	.36	.40	.48

Example Problem
Putting it all together

An onion producer has a drip irrigation system:

The flow rate of drip tape is 0.2 gallons per hour per foot of tape.

The drip tape spacing is 40 inches.

The irrigation efficiency is 85 percent.

The soil has a readily available water holding capacity of 1 inch per foot of rooting depth.

The desired net irrigation depth is 1 inch per irrigation.

The rooting depth is 1.5 feet.

The projected average ET rate for the next week is 0.2 inches per day.

Determine:

What is the gross application amount per irrigation (inches)? **(1 inch / 0.85 = 1.18 inches)**

What is the recommended irrigation frequency (days)? **(1 inch net irrigation / 0.2 in./day = 5 days)**

How many hours is the irrigation set time**? (1.6 * 0.2 gph / (1 ft x (40 in / 12 in/ft) = 0.096 in/hr)** then **(1.18 in / 0.096 in/hr = 12.3 hours)**

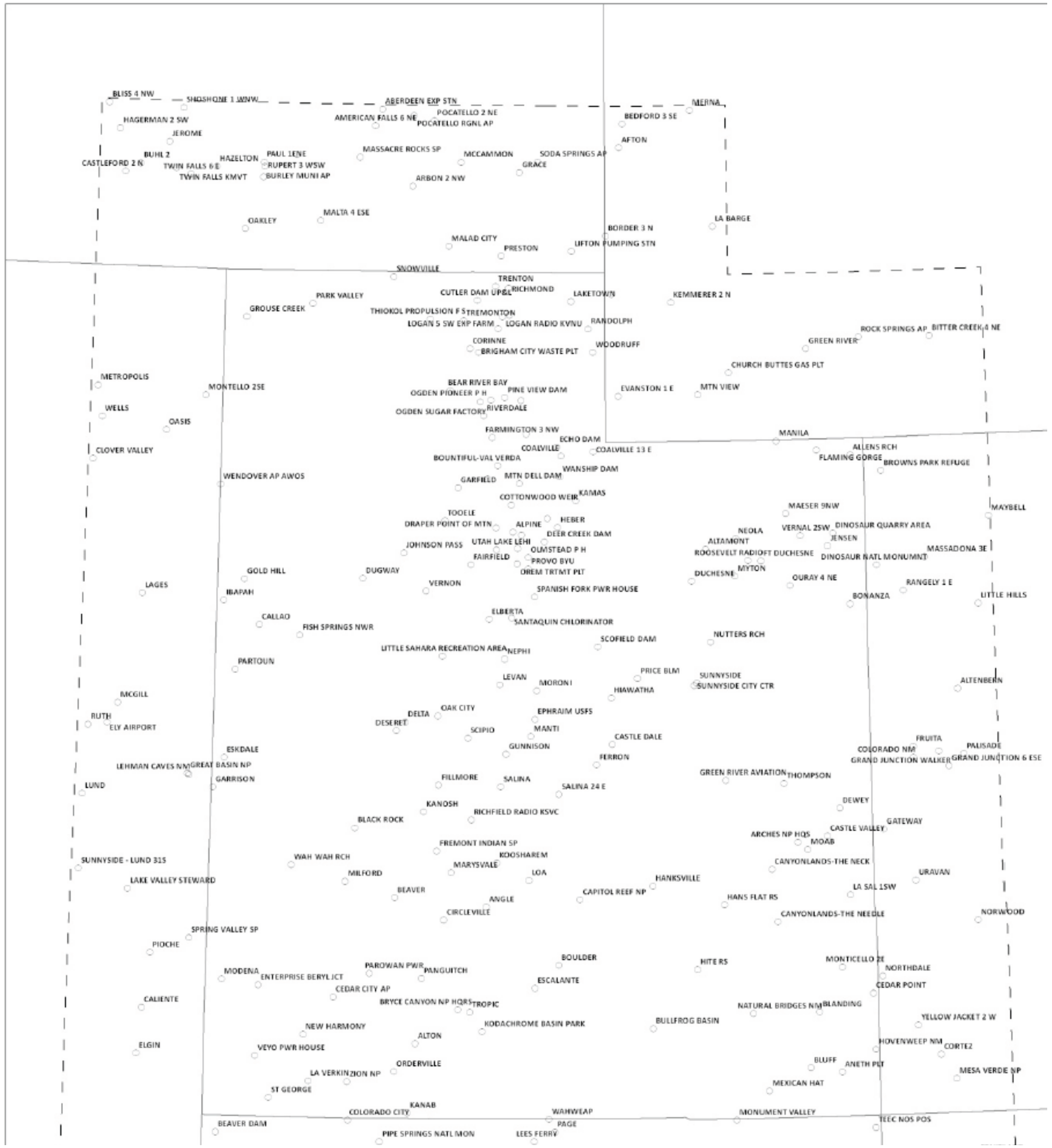
If the irrigation frequency was changed to 3 days how many hours would the irrigation set be? **(3 days/irr * 0.2 in/day = 0.6 net in./irr.), (0.6 in/irr. / 0.85 = 0.71 inches/irr.),** then **(0.71 in/irr / 0.096 in/hr = 7.4 hours)**

Note: Our net irrigation depths are below the 1.5 inches of readily available soil moisture.

National Weather Service Site

ET in Report

Crop and Wetland Consumptive Use and Open Water Surface Evaporation for Utah
APPENDIX I: Updated Consumptive Use Estimates at NWS Stations
and
APPENDIX J
Electronic Weather Stations



https://extension.usu.edu/irrigation/

Estimated Consumptive Use for EWS: USU Murray Golf Course

Aridity Index: 0%, Temp. Adj. (F): 0, Period: 2000-2010, Lat: 40.63, Long: -111.92, Elev: 4290 ft, 8/25/2011

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Temp (F)	31.16	35.17	42.78	50.23	58.95	67.81	77.26	74.31	64.35	52.17	39.67	31.46	52.11
St Dev	4.56	2.76	2.57	2.29	2.69	1.92	1.61	2.07	2.08	2.45	3.18	3.45	0.90
Precip (in)	0.68	0.84	1.30	1.63	1.61	1.18	0.71	0.81	1.02	1.29	0.88	0.77	12.72
St Dev	0.49	0.65	0.62	0.81	0.94	0.79	0.72	0.49	0.63	1.00	0.71	0.50	2.57
Aridity Adj. (F)													
Est. Dewpoint (F)	23.39	24.94	27.25	31.05	37.10	41.81	47.79	47.49	41.08	35.76	28.36	24.04	34.17
Rs (langleys/day)	165	249	381	483	589	648	639	547	459	308	201	147	401
Wind (mpd)	77	85	103	115	94	90	82	90	79	77	73	82	87
Calc. Wind Limit (mpd)	96	96	105	114	96	96	96	96	96	96	96	96	98
							Inches						
Alfalfa (Beef)				2.76	5.75	7.37	7.03	6.33	5.10	2.07	0.23		36.63
St Dev				0.54	0.32	1.00	0.44	0.32	0.44	0.72	0.43		2.26
Net Irr				1.46	4.46	6.42	6.46	5.68	4.29	1.04			29.81
Alfalfa (Dairy)				2.76	5.27	6.16	7.08	6.27	4.46	2.33	0.10		34.44
St Dev				0.54	0.41	0.64	0.41	0.26	0.35	0.44	0.19		1.99
Net Irr				1.46	3.98	5.21	6.51	5.62	3.65	1.30			27.74
Apples / Cherries				1.55	5.79	8.59	9.75	8.34	4.88	2.00			40.90
St Dev				0.29	0.66	0.89	0.59	0.39	0.46	0.30			2.43
Net Irr				0.25	4.51	7.65	9.18	7.70	4.07	0.97			34.31
Barley				1.54	5.98	7.94	1.52						16.98
St Dev				0.35	0.89	0.69	0.82						0.92
Net Irr				0.24	4.69	6.99	0.95						12.88
Corn					1.06	4.37	8.99	4.82	0.20				19.43
St Dev					0.21	1.10	0.62	1.07	0.23				0.95
Net Irr						3.42	8.42	4.18					16.01

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Melon					1.08	4.49	6.09	5.32	3.52	0.02			20.51
St Dev					0.26	0.61	0.37	0.25	0.41	0.04			1.16
Net Irr						3.54	5.52	4.67	2.70				16.43
Onion				0.13	3.35	6.51	9.37	7.86	2.25				29.46
St Dev				0.16	0.37	0.82	0.57	0.37	0.40				1.67
Net Irr					2.06	5.56	8.80	7.21	1.43				25.07
Other Hay				2.77	7.03	7.51	4.06	2.59	1.07				25.03
St Dev				0.51	0.68	0.77	0.27	0.14	0.17				1.66
Net Irr				1.47	5.75	6.56	3.49	1.94	0.26				19.47
Other Orchard				1.44	5.55	7.94	9.00	7.67	4.41	1.98			37.98
St Dev				0.27	0.63	0.82	0.54	0.35	0.41	0.29			2.27
Net Irr				0.14	4.26	6.99	8.43	7.02	3.60	0.95			31.38
Pasture			0.08	2.44	4.68	5.62	6.37	5.56	3.91	2.08	0.38		31.12
St Dev			0.08	0.27	0.43	0.58	0.38	0.27	0.35	0.31	0.36		1.92
Net Irr				1.14	3.39	4.68	5.80	4.91	3.09	1.05			24.07
Potato					1.52	5.29	7.00	3.26					17.09
St Dev					0.37	0.85	0.38	0.89					0.83
Net Irr					0.24	4.35	6.43	2.61					13.63

Estimated Consumptive Use for EWS: USU Murray Golf Course

Aridity Index: 0%, Temp. Adj. (F): 0, Period: 2000-2010, Lat: 40.63, Long: -111.92, Elev: 4290 ft, 8/25/2011

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
							Inches						
Spring Grain				1.48	5.78	8.23	2.49						17.98
St Dev				0.34	0.91	0.72	1.02						0.88
Net Irr				0.18	4.50	7.28	1.92						13.88
Winter Wheat			0.82	2.25	6.47	6.51	0.60						16.66
St Dev			0.11	0.46	0.97	0.95	0.46						0.74
Net Irr				0.95	5.19	5.57	0.03						11.73
Garden				0.10	1.85	3.83	7.08	5.98	1.28				20.13
St Dev				0.12	0.21	0.49	0.54	0.30	0.25				1.15
Net Irr					0.57	2.89	6.51	5.33	0.47				15.77
Small Fruit					1.40	5.19	9.08	7.78	3.87				27.34
St Dev					0.31	0.76	0.62	0.36	0.54				1.51
Net Irr					0.12	4.25	8.51	7.14	3.06				23.07
Turfgrass			0.13	2.42	3.99	4.96	5.62	4.91	3.47	2.03	0.43		27.97
St Dev			0.14	0.20	0.38	0.52	0.34	0.23	0.30	0.26	0.38		1.67
Net Irr				1.12	2.70	4.02	5.05	4.26	2.65	1.00			20.81
Turfgrass Dixie			0.15	2.62	3.93	5.38	6.09	5.32	3.76	2.20	0.49		29.93
St Dev			0.16	0.21	0.39	0.56	0.37	0.25	0.32	0.28	0.44		1.80
Net Irr				1.31	2.64	4.43	5.52	4.67	2.94	1.17			22.69
Open Water Deep	0.92	1.01	1.63	2.29	2.88	3.95	5.27	5.36	3.34	2.29	1.35	0.91	31.20
St Dev	0.24	0.22	0.22	0.29	0.56	0.81	0.74	0.63	0.55	0.42	0.33	0.21	3.10
Net Evap	0.24	0.17	0.33	0.66	1.28	2.77	4.55	4.55	2.32	1.00	0.47	0.14	18.48
Open Water Shallow	0.87	1.37	2.81	3.93	5.20	5.90	6.60	5.83	4.33	2.59	1.28	0.77	41.48
St Dev	0.14	0.14	0.23	0.30	0.37	0.50	0.27	0.19	0.28	0.23	0.18	0.12	1.35
Net Evap	0.19	0.53	1.50	2.30	3.59	4.72	5.89	5.02	3.32	1.31	0.40		28.77
Wetlands Large					0.49	5.35	9.69	8.59	6.07	3.31	0.32		33.81
St Dev					0.26	0.91	0.65	0.41	0.52	0.35	0.59		2.14
Net ET						4.41	9.12	7.94	5.25	2.28			28.99
Wetlands Narrow					0.58	7.36	13.83	12.27	8.67	4.73	0.45		47.88
St Dev					0.32	1.31	0.94	0.59	0.74	0.50	0.84		3.03
Net ET						6.42	13.26	11.62	7.85	3.70			42.84
ETr	1.14	1.71	3.62	5.27	6.93	8.27	9.37	8.18	5.78	3.38	1.67	1.02	56.34
St Dev	0.21	0.23	0.31	0.42	0.62	0.86	0.56	0.39	0.49	0.43	0.32	0.20	2.83

All values are 11 year averages. Effective precipitation is 80% of total for crops and 100% of total for open water evaporation.

Estimated Consumptive Use for NWS Station: RICHFIELD RADIO KSVC

Aridity Index: 32%, Temp. Adj. (F): -3, Period: 1971-2008, Lat: 38.76, Long: -112.08, Elev: 5300 ft, 8/25/2011

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
						. . . . Inches							
Garden					0.58	2.64	4.77	6.64	2.02				16.64
St Dev					0.08	0.18	0.23	0.51	1.17				1.57
Net Irr						2.17	4.21	6.03	1.32				13.73
Turfgrass				1.63	3.76	5.37	5.44	5.06	3.30	0.53			25.08
St Dev				0.20	0.29	0.38	0.25	0.19	0.56	0.62			1.40
Net Irr				1.12	2.99	4.90	4.88	4.46	2.60				20.95
Open Water Deep	0.65	0.86	1.97	2.56	3.03	4.11	4.37	4.52	2.87	2.34	1.34	0.72	29.35
St Dev	0.15	0.17	0.29	0.32	0.32	0.38	0.28	0.19	0.19	0.24	0.21	0.15	1.21
Net Evap	0.19	0.47	1.38	2.05	2.27	3.64	3.82	3.92	2.17	1.54	0.83	0.32	22.60
Open Water Shallow	0.76	1.47	2.87	4.04	4.85	5.73	5.84	5.69	4.24	2.67	1.29	0.77	40.22
St Dev	0.14	0.21	0.28	0.31	0.28	0.30	0.20	0.15	0.18	0.20	0.17	0.14	1.05
Net Evap	0.30	1.08	2.28	3.54	4.09	5.26	5.29	5.08	3.54	1.86	0.78	0.37	33.46
Wetlands Large					0.24	5.06	9.20	8.83	4.22	0.14			27.70
St Dev					0.13	0.64	0.47	0.39	1.72	0.33			2.39
Net ET						4.59	8.65	8.23	3.52				24.99
Wetlands Narrow					0.27	6.85	13.13	12.61	6.03	0.20			39.10
St Dev					0.14	0.92	0.68	0.55	2.46	0.48			3.41
Net ET						6.38	12.58	12.01	5.33				36.30
ETr	1.00	1.80	4.19	5.95	7.26	8.95	9.06	8.43	6.10	4.12	2.01	1.03	59.92
St Dev	0.26	0.36	0.57	0.61	0.55	0.64	0.41	0.32	0.35	0.44	0.38	0.28	2.19

All values are 38 year averages. Effective precipitation is 80% of total for crops and 100% of total for open water evaporation.

Irrigation Uniformity = Yield Uniformity

The yield impact is the obvious. Some yield impacts are as real but not as obvious.

Horticulture

EXTENSION Utah State University

extension.usu.edu

August 2017 Horticulture/Irrigation/2017-01pr

Drip Irrigation for Commercial Vegetable and Fruit Production

Tiffany Maughan, Niel Allen, and ***Dan Drost***

Drip irrigation is a highly efficient irrigation method well suited to many fruit and vegetable row crops. Drip tubing or tape discharges water to the soil through emitters positioned close to the plant. The drip tubing can be placed uncovered on the soil surface, under plastic mulch, buried in the soil, or suspended above the ground (e.g., on a trellis system). Water application rate is relatively low and irrigations are usually frequent. Properly designed and maintained drip-irrigation systems can have benefits that help increase the profitability of crop production.

Advantages

Reduced Water Use: One important advantage for growers with limited or expensive water is the water savings that a well-designed and managed drip system provides. Drip irrigation can minimize runoff, deep-percolation, and evaporation. Irrigation application uniformity is improved and application occurs directly to the plant's roots. Drip irrigation allows for frequent, efficient irrigation that works well for establishing crops and for shallow rooted crops.

Decreased Weed and Disease Pressure: Since the inter-row and non-cropped field edges are not watered with a drip system, weed growth is limited in comparison to sprinkler and flood irrigation. Drip irrigation keeps water off the plant canopy, thus reducing foliar disease development on many plants. Both of these benefits can lead to reduced pesticide use, leading to chemical and labor savings.

Lower Pumping Needs than Sprinklers: Drip irrigation uses a lower water pressure (35-40 psi for most systems) than sprinkler irrigation (50-80 psi). Additionally, lower flowrates are possible due to higher irrigation efficiencies. These factors reduce pumping costs when operated properly.

Uninterrupted Field Operations: In general, traffic rows should remain dry, allowing access to conduct field operations during or soon after watering. This simplifies timing of tillage, application of pesticides, harvesting, and other field operations.

Fertilizer Application: Precise fertilizer application is possible through the drip irrigation system due to high irrigation application uniformity and irrigation efficiency. Additionally, soluble nutrient losses are reduced due to decreased deep percolation and surface runoff. This reduces fertilizer costs and/or improves crop yields.

Adaptable: Drip systems are suitable for uneven topography and oddly shaped fields. For some fields this is an advantage over surface irrigation due to high land leveling costs and issues caused by disturbing soil profiles. It also has some advantages over sprinkler irrigation on small and odd shaped fields because the poorest uniformity with sprinkler irrigation occurs at field edges due to a lack of proper application overlap from sprinklers.

Figure 1. Commercial pepper field with drip irrigation and plastic mulch and farmers market grower with drip tubing on ground

Disadvantages

Cost: Initial investment in a drip system typically ranges from $1,200 to $2,000 per acre. Additionally, there is specialized equipment needed to install and remove the drip tape. Some parts of the system last 30 years or more (filter, pump, delivery line, etc.), but drip tape or drip tubing lasts 1 to about 10 years. For some annual crops, less expensive thin wall drip tape is used and discarded each year. Replacing drip tape each year can cost about $400 per acre depending on emitter spacing, wall thickness, and row spacing. Thicker-walled drip tape or tubing is used in perennial crops and is left in place for several years. While costs are high, the decision to use drip systems should be to increase profitability through better crop quality and yields.

Need for Clean Water*:* Debris and sediments in irrigation water can easily plug small emitters. It is important to use filtered water in order to avoid clogging. Depending on the water source, multiple filtration systems, such as a settling pond combined with a media filter and/or other with inline filters, may be needed. Additionally, bacteria/algae growth and mineral deposition from irrigation water can plug emitters. These conditions can be prevented with disinfectants such as chlorine to control biological growth and acid to dissolve chemical precipitates and buildup.

Leak repair*:* Drip tape can easily be damaged by equipment, insects, rodents, or even by deer stepping on it. Leaks need to be fixed in order to keep the system running efficiently. In general, leak repair parts are inexpensive but can be costly in labor. Farmers may need to control rodents and insects to protect drip tape. Some farmers have found that using 6 to 8 mil. (1 mil. is 1/1000 of an inch) wall thickness helps reduce leaks on tubing that is replaced each year. Drip tape installed for multi-year use generally has a thicker wall, such as 10 to 15 mil. Drip tubing with a wall thickness of 50 to 70 mil. is suitable for many years of use above or below the ground with less potential for leaks.

Plastic disposal*:* The annual replacement of some types of drip tape results in significant plastic disposal into the landfill, incurring disposal costs and causing environmental concern. Additionally, taking up the drip tape adds to labor costs. Drip tape buried deeper than about 5 inches is harder to retrieve. If the tape is in the tillage layer it gets torn-up and incorporated into the soil. The tape does not harm the soil, but can be a nuisance.

Labor costs: The installation and removal of drip tape requires concentrated labor efforts. However, the total irrigation labor costs may be less, because of the automation capabilities of a drip system.

Components of a Drip System

Drip systems have several basic parts, and multiple options are available for each component. A typical system includes the water source, pumping system, filtration, pressure regulators, chemical injectors, distribution network, and drip tape. A short video, https://www.youtube.com/watch?v=it8EJw7cGnk, shows the components of a drip irrigation system used to irrigate an onion crop. These components are detailed below. Drip tape, tube, and emitters vary in their specifications and the distribution system must match the supply requirements of the tape.

***Water Sources and Distribution**:* Water for drip irrigation can be from surface (canal, creek, pond), groundwater (well), and/or potable sources. Generally, existing sources of irrigation water are suitable for drip irrigation. Drip irrigation requires an on-demand and sometimes nearly continuous supply of water. If the source of water is not continuous, such as a periodic water delivery schedule, then an on-farm reservoir with adequate volume may be needed to supply the drip irrigation system. Water diversion from surface supplies or from a reservoir usually requires screening in addition to the filtration system downstream of the pump. Water filtration is required to prevent clogging of drip emitters. Well water may also need to be filtered but not as extensively as surface water. Potable water is high quality, clean water but is usually more expensive than other sources and may have limited availability. Culinary or potable water is also more likely to have restrictions for agricultural use than other sources. Depending on the location of the field and the water source, a surface or buried pipe distribution system may be needed.

***Pumping System*:** Drip irrigation systems require pressurized water. Pressurized irrigation lines and potable water do not require a pumping system, but other water sources do. The size of pump must match the supply requirements of the drip system. If a pump from sprinkler irrigation system is used for a new drip system, the impeller can often be trimmed to reduce the pressure (preferable) or alternatively the water pressure can be controlled with pressure reduction valves

Figure 2. Pump for commercial drip irrigation system.

Filtration: Since drip-irrigation water passes through small emitters, the size of particles in the water must be smaller (recommended 4 times smaller) than the size of the emitter in order to prevent clogging. A 200-mesh screen equivalent is sufficient for most systems. Filter mesh value is inversely related to the size of screen openings. This means a 200-mesh filter stops smaller particles than a 100-mesh filter. There are several different filtration options and all can be used alone or in conjunction with another filter. Clogging will quickly occur if the incorrect filter is used. Unless your water source is culinary, never operate a drip system without a filter system as clogged emitters can cause irreparable damage. Placing chemical injection systems upstream of the filtration systems prevents possible chemical precipitates from clogging emitters. Injected disinfectants are used to control bacteria in filters. One exception may be to prevent discharge of chemicals during back-flushing of media filters.

– <u>*Media filters*</u> are an excellent choice for large-scale commercial vegetable and fruit production using groundwater to irrigate. They are heavy, large, and are often installed in sets of two or more. They are more expensive than some filter options but are highly effective at cleaning poor-quality water, even at high flow rates. Media filters catch debris in sand or crushed rock inside the filter and water is cleaned as it moves through the media. At least two filters allows one to backflow and wash while the other(s) is filtering water for the drip system.

Figure 3. Media filters (four silver tanks).

- *Screen filters* are also commonly used on small acreage production operations and can be used as backup filters downstream of a primary filter system. Screen filters work best with water that is already somewhat clean, such as groundwater. They are as effective at removing particles from the water as a media filter but cannot filter at the same scale. Regular cleaning is critical and is required more often than for media filters. Screen filters are typically equipped with a flush valve that makes filter cleaning easy. Using a large screen filter before a small screen filter will help to decrease the frequency of cleaning required.
- *Disk filters* are composed of stacks of doughnut-shaped disks. Water moves from outside the disks to the inside, being cleaned in the process. A disk filter's cleaning capacity is higher than for screen filters but lower than for media filters. Filter cleaning is more involved than for media or screen filters. To clean disk filters, the disks need to be separated and washed with pressurized water.

Pressure Regulators and Gauges: Drip tape cannot withstand high pressures. For most systems, the recommended operating pressure is 8 to 15 psi once the water reaches the drip tape. High water pressure can burst open the tape, requiring it to be replaced. In order to achieve this low and constant pressure, a pressure regulator should be installed in-line. Pressure gauges are installed to monitor the water pressure and make sure the pressure regulator is operating as expected. Gauges can be installed anywhere along the system, including using portable ones that can be temporarily installed at the end of the drip tape to measure pressure at the end of the line.

Figure 4. Water delivery line with combination pressure regulating and on-off control valve.

Chemigation*:* Injectors allow the introduction of fertilizers, pesticides, or anti-clogging chemicals directly into the irrigation water. Fertilizer application in this way is particularly useful when plastic mulch is used over the top of the irrigation line and access to the soil is limited. Chemigation delivers chemicals directly to the root zone of the plants. This allows for precision application, resulting in increased efficiency (use less material) and can increase pesticide application safety. Chemicals for system maintenance can be used to kill algae or dissolve precipitates that clog emitters. Verify the product injected is water soluble to prevent chemical precipitation that will lead to clogging of emitters.

When injecting material into the irrigation line, a backflow-prevention device must be used to prevent contamination to the main water supply. Different types of injectors are available, and the best injector for a given system depends on the type of chemical injected. When injecting fertilizer, the most important consideration is to ensure that the injector has a high enough flow rate to apply the desired amount of fertilizer in a reasonable timeframe. An injector with a capacity of 1 gallon per minute (gpm) is suitable for fertilizer injection into systems for zones of less than 10 acres. Maintaining an exact injection rate is not as important for fertilizer application compared to other chemicals, as long as continuous injection is not used. When injecting anti-clogging chemicals, a very low injection rate is used that must be highly accurate. To accurately apply low rates (often just 1 to 10 ppm) a different type of injector from the high-flow type for fertilizer application is used. Follow all safety precautions.

Pesticide injection can be accomplished with either high or low flow types. In addition to deciding between high-flow/low-accuracy and low-flow/high-accuracy injectors, the type of power available affects your choice of injectors. Injectors can run via electricity, small engines, or even the water pressure of the irrigation system.

Distribution systems*:* Once the water has been pumped, filtered, regulated, and delivered to the field, it is delivered into a header/manifold line to which individual drip lines are connected. A valve (manual or automated) is usually installed between the distribution pipeline and the header/manifold. A header line can be flexible poly pipe, PVC, or vinyl lay-flat hose. The header line and connectors are gathered and stored over the winter each year for re-use the following spring.

Figure 5. Flexible pvc header line with manual connectors drip tape.

Drip Tape/Tubing: There are many different considerations and options when selecting drip tape. Emitter spacing, flow rate, wall thickness, and diameter vary depending on the selected type. Understanding each of these parameters is important for selecting the right tape for your field.

Figure 6. Lay-flat 3-inch manifold connected to 17 mm diameter, 6 mil. wall thickness, drip line.

Drip tape (or tubing), is made with thin polyethylene with small, regularly placed emitters to allow for slow water discharge. Emitter spacing suitable for vegetable production varies from 4 to 18 inches. Desirable emitter spacing depends on the crop being grown and the soil. Onions, with small root zones and close spacing benefit from 4 to 8 inch spacing. Tomatoes, with greater spacing and larger root zones grow well with 12 inch spacing. Soil type also plays into deciding on emitter spacing. Sandy soils or cracking soils require closer spacing than loam or clay-loam soils due to different water movement patterns in the soil. Drip tape is installed with the emitters facing up to prevent clogging when sediment settles to the bottom of the tape.

Flow rate can be expressed in gallons per hour (gph) per 100 feet of tape (gal/hr./100 ft.) or by single emitter emission rate in gph. Without adequate filtration, lower flow drip (i.e., < 0.25 gph/emitter) tapes are more prone to clogging than higher flow drip tape. Pressure compensating emitters provide better irrigation uniformity on sloping fields or when drip lines are long.

Drip tape wall thickness ranges from 4 to 25 mil. (1 mil. is 1/1,000 of an inch). Thin tape (4 to 8 mil.) is meant to be used for 1 year and then discarded. Thicker drip tape can be used for more than 1 year. Tape cost is related to wall thickness and diameter with price per foot increasing with wall thickness.

Drip tape diameters range from 5/8 inch to 1 3/8 inch, with 5/8 and 7/8 inch being most common. The selection of drip tape diameter and emitter flowrate is based on economics and field dimensions.

Drip tubing (as opposed to tape) wall thickness ranges from 50 to 70 mil. depending on diameter. Drip tubing is well suited to irrigation of perennial crops (i.e., asparagus, grapes, raspberries, etc.), small areas where the tubing can be removed each year for tillage and planting, or buried in fields that require only shallow cultivation and tillage. Drip tubing can be buried using GPS- (global positioning systems) guided equipment and then row tillage and planting can occur over the buried tube lines using GPS-guided equipment and planters.

It is best to rely on manufacturer information and tables concerning drip tape or tubing specifications. Manufacturers provide information about emitter discharge at different pressures, uniformity of emitter discharge, allowable length of run, and filtration requirements. In most field applications, low emitter discharge rates are used to accommodate longer drip line runs (fewer manifolds and lower costs). It is critical to know the drip system's application rate (i.e., inches per hour) to schedule irrigation and determine operation times. To schedule irrigations, you can calculate water use from crop ET estimates or measured soil moisture. Either way you will determine an application depth per irrigation. The time required for the application is based on your drip line application rate. The following formula is used to calculate the drip system application rate.

Drip Irrigation Application Rate (based on the flow per emitter in gallons per hour, or gph):

Rate (in/hr) = 1.6 times emitter discharge rate (gph) divided by emitter coverage area (ft^2)

Note: emitter coverage area is calculated as the emitter spacing times the line spacing).

Example: 1.6 x 0.5 gph / (1 ft x 2.5 ft) = 0.32 in/hr.

See the USU fruit and vegetable irrigation guides listed at the end of this document for detailed irrigation scheduling information by crop.

Table 1 provides examples of water application rates based on emitter flow rate and drip line spacing. Emitter flow rates around 0.2 gph per foot are typical of drip tape used in fields. It is best to do specific calculations and then use the table to check if the calculations appear correct. While drip systems have good application uniformity and minimize water loss, they are not 100 percent efficient. A typical irrigation efficiency would range from 85 to 90 percent to account for non-uniformity of application and leakage or other losses. Gross irrigation is equal to net irrigation divided by application efficiency (i.e., 1 inch divided by 85% (or 0.85) equals 1.18 inches).

Table 1. Application rates and minutes of irrigation to apply 1 inch of water.

Irrigation Application Rates and Time		Drip Tubing/Tape Emitter Flow Rate (gallon per hour per foot)				
		0.2	**0.5**	**0.6**	**0.9**	**1**
		Application Rate (Inches/hour)				
Drip Tubing Row Spacing (inches)	**12**	0.32	0.80	0.96	1.44	1.60
	18	0.21	0.53	0.64	0.96	1.07
	24	0.16	0.40	0.48	0.72	0.80
	30	0.13	0.32	0.38	0.58	0.64
	36	0.11	0.27	0.32	0.48	0.53
		Minutes to Apply 1 Inch				
	12	187	75	62	42	37
	18	281	112	94	62	56
	24	374	150	125	83	75
	30	468	187	156	104	94
	36	561	224	187	125	112

Irrigation Design

A successful drip irrigation system requires careful planning, accounts for field topography, drip tape flow specifications, and field layout. Drip line spacing can be one line per row or bed with multiple rows of crop (spacing can range from 2.5 feet to 6 feet or more). Some producers use a double drip line (one on each side of crop row) for a single row of widely spaced crops like watermelon or squash. The spacing and number of drip lines is a complex integrated function of soil hydraulic properties, grower experience, enterprise economics, and farmer preference. For complex systems, consult an irrigation engineer or irrigation system consultant who has been trained and certified to properly design drip irrigation systems.

Due to inefficiencies in the system, plan on slightly over-sizing the system (supply 110-120% of plant needs). Crop needs vary greatly but an average water need for vegetable crops is 1.5 inches of water each week. See the Additional Reading section at the end of this document for a list of crop-specific irrigation recommendations for Utah.

Drip irrigation systems may be divided into zones. A zone is an area that is irrigated separately from other areas. In designing zones consider water supply, system capacity, field topography, field size, maximum length of drip tape laterals, and filter capacity. Manufacturer's recommended maximum values for drip tape length are generally between 400 to 600 feet, but can be over 1,000 feet with low flowrates and pressure compensating emitters and proper drip tape diameter. If tape is used in excess of recommended length, uneven application occurs. Strive to keep zones approximately the same size to maximize efficiency.

Maintenance

Prevention is the best way to keep your system working well. Be sure to use the appropriate filter for your irrigation water source and regularly clean it as needed. Drip lines and manifolds should be flushed periodically to remove settled debris by opening the ends of header line and/or drip tape. Injecting a cleaning compound, such as chlorine gas or sodium hyprochlorite can also clean the line. Periodic injections of sulfuric or phosphoric acid is used to prevent scaling from hard water. Care should be taken to apply the right amount and the use the correct injector type. As long as the chlorine is applied correctly, the amount of chlorine is so low that no damage to the crop results. Routinely check drip lines for leakage and repair leaks promptly. Use all chemicals as directed. Carefully follow all safety precautions when using chemical injects to prevent human harm. Chlorine gas is harmful and can react with other chemicals.

National Drip Irrigation Supply Sources (listed alphabetically) – An internet search can help find local drip irrigation equipment designers, installers, and suppliers.

BWI-Springfield,
Springfield, MO
www.bwicompanies.com

Hummert International
Topeka, KS
www.hummert.com

Hydro-Gardens,
Colorado Springs, CO
www.hydro-gardens.com

Irrigation-Mart, Inc.,
Ruston, LA
www.irrigation-mart.com

Irrometer Company, Inc.,
Riverside, CA
www.irrometer.com

Jain Irrigation, Inc.,
Watertown, NY
www.jainsusa.com

Netafim USA,
Fresno, CA
www.netafim-usa.com

Rain Bird Corporation: Agricultural Irrigation Resources,
Glendora, CA
www.rainbird.com/ag/index.htm

Rain-Flo Irrigation,
East Earl, PA
www.rainfloirrigation.com

Schumacher Irrigation, Inc.,
Platte Center, NE
www.schumacherirrigation.com

Spring Brook Supply,
Holland, MI
www.springbrookirrigation.com

The Toro Company,
Riverside, CA
Sprinkler and Drip Irrigation Planning & Installation Guide
www.toro.com/sprinklers/guides.html

Trickl-eez Company,
St. Joseph, MI
www.trickl-eez.com

WeatherMatic Company,
Garland, TX
Automated Water Management Systems
www.weathermatic.com

Additional Reading

Shock, C.C. 2013. Drip Irrigation: An Introduction. Sustainable Agriculture Techniques, Oregon State University. EM 8782
http://extension.oregonstate.edu/sorec/sites/default/files/drip_irrigation_em8782.pdf

Peters, R. T. 2011. Drip Irrigation for the Yard and Garden. Washington State University. Extension fact Sheet FS030E
http://cru.cahe.wsu.edu/CEPublications/FS030E/FS030E.pdf

Simonne, E., R. Hochmuth, J. Breman, W. Lamont, D. Treadwell, and A. Gazula. 2015. Drip-Irrigation Systems for Small Conventional Vegetable Farms and Organic Vegetable Farms. IFAS Extension, University of Florida. HS1144.
http://edis.ifas.ufl.edu/pdffiles/HS/HS38800.pdf

Lamont, W.L., M.D. Orzolek, J.K. Harper, L.F. Kime, and A. R. Jarrett. 2012. Drip Irrigation for Vegetable Production. Ag Alternatives, PennState Extension. UA370.
http://extension.psu.edu/business/ag-alternatives/horticulture/horticultural-production-options/drip-irrigation-for-vegetable-production

Burt, 2008. Avoiding Common Problems with Drip Tape. Irrigation Training and Research Center, California Polytechnic State University, San Louis Obispo, California.
http://www.protos.ngo/sites/default/files/library_assets/423.2_BUR_E8_avoiding_common.pdf

USU Fruit and Vegetable Irrigation Guides

- Apple
- Cherry
- Melon
- Onion
- Peach
- Pepper and Tomato
- Raspberry and Blackberry
- Squash and Pumpkin
- Strawberry

This project is funded in part by USDA-Risk Management Agency under a cooperative agreement. The information reflects the views of the author(s) and not USDA-RMA.

EXTENSION UtahStateUniversity

USDA

Back to Top

Experience with Drip Irrigation

A quick discussion on the trials and triumphs of installing and using a drip irrigation setup.

Chris Natalie
Farm Incubator Specialist
New Roots SLC

New Roots seeks to build a healthier community through the development of small scale, urban farms and community gardens while increasing food access for refugees in Salt Lake City. Last year, the New Roots Farm Stand provided over 200 households with healthy, organic produce grown by refugee farmers. During the 2018 season New Roots sustained the Sunnyvale Farmers Market and expanded retail sales with local school districts, universities, businesses and grocery stores, and placed over 110 families in community gardens across Salt Lake County. Over the past season, New Roots farmers earned over $40,000 on two acres and have provided fresh produce to over 500 families.

The three focuses of New Roots in Salt Lake City are:

Community Gardening

· Securing plots for 110 refugee families at community gardens throughout Salt Lake City.

· Providing seeds, seedlings and instruction on gardening practices in an arid, high desert environment.

· Hosting garden-based mental health adjustment groups for refugee clients.

Food Access

· Providing low-income communities with access to SNAP- accessible, affordable produce.

· Matching SNAP purchases dollar for dollar through our Fresh Fund.

· Educating refugees on food literacy topics such as Nutrition and Diabetes Management.

· Food Bank Distribution site: provides free shelf stable, commodity foods for around 75 families per week.

Micro-Training Farm Program

· Facilitating greater economic independence through market farming.

· Providing training and technical assistance to farmers from countries as diverse as Sudan, Burma, Bhutan, Chad, DR Congo, and Burundi.