SWSI Automation Project Phase II

CWCB and DWR

September 21, 2015

Open Water Foundation

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

COLORADO
Division of Water Resources
Department of Natural Resources

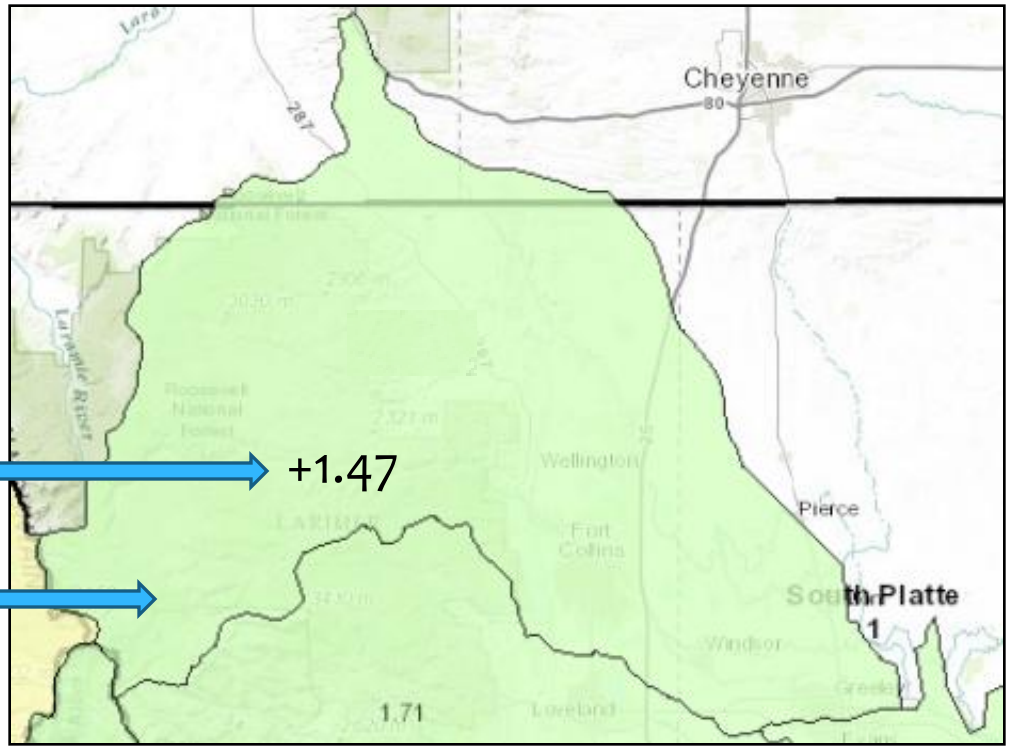
Surface Water Supply Index

* **What is SWSI?**

Time Period	Components
January - June	Forecasted Runoff + Reservoir Storage
July - September	Previous Month's Streamflow + Reservoir Storage
October - December	Reservoir Storage

SWSI Value

Hydrologic Unit Code (HUC8)



Surface Water Supply Index

* **Example Step 1:**

Year	Volume* of water in HUC	NEP
May 1999	460,388	
May 1996	453,066	
May 1974	440,361	
May 1979	411,037	
May 1998	396,116	
May 1993	394,651	

* Rank the volume available to a HUC over all the Mays in the last 40 years.

*Volume = Reservoir Storage + Forecasted Runoff

Surface Water Supply Index

* **Example Step 1:**

Year	Volume* of water in HUC	NEP
May 1999	460,388	76.12
May 1996	453,066	73.63
May 1974	440,361	71.14
May 1979	411,037	68.66
May 1998	396,116	66.17
May 1993	394,651	63.68

*Volume = Reservoir Storage + Forecasted Runoff

* Rank the volume available to a HUC over all the Mays in the last 40 years.
* Use ranking to calculate the non-exceedance probability.

Surface Water Supply Index

* **Example Step 2:**

Year	Volume* of water in HUC	NEP
May 1999	460,388	76.12
May 1996	453,066	73.63
May 1974	440,361	71.14
May 1979	411,037	68.66
May 1998	396,116	66.17
May 1993	394,651	63.68

* Calculate the volume available to the HUC *this* May
* Insert into ranking by volume

May 2015	429,100 AF

*Volume = Reservoir Storage + Forecasted Runoff

Surface Water Supply Index

* **Example Step 3:**

Year	Volume* of water in HUC	NEP
1999	460,388	76.12
1996	453,066	73.63
1974	440,361	71.14
2015	429,100	Interpolation: 70.19
1979	411,037	68.66
1998	396,116	66.17
1993	394,651	63.68

*Volume = Reservoir Storage + Forecasted Runoff

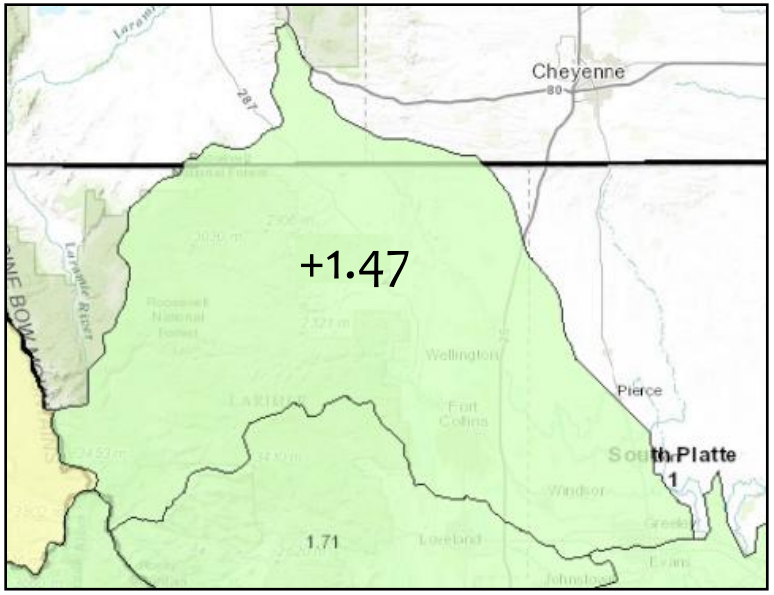
* Interpolate to get the NEP value for *this* May
* Use NEP value to calculate SWSI

$$SWSI = \frac{NEP - 50}{12}$$

SWSI = + 1.47

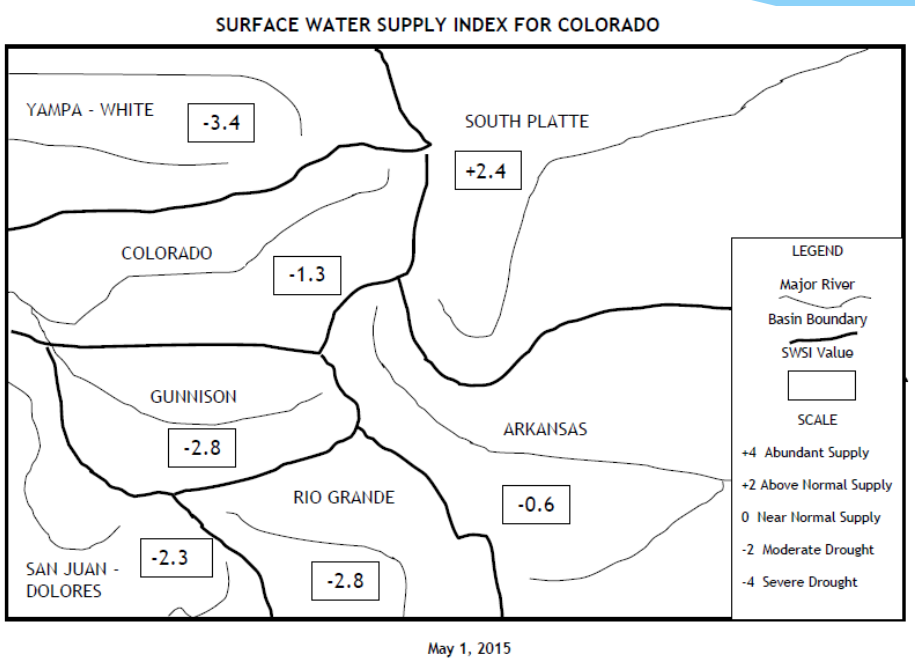
Surface Water Supply Index

* **Example Step 4:**

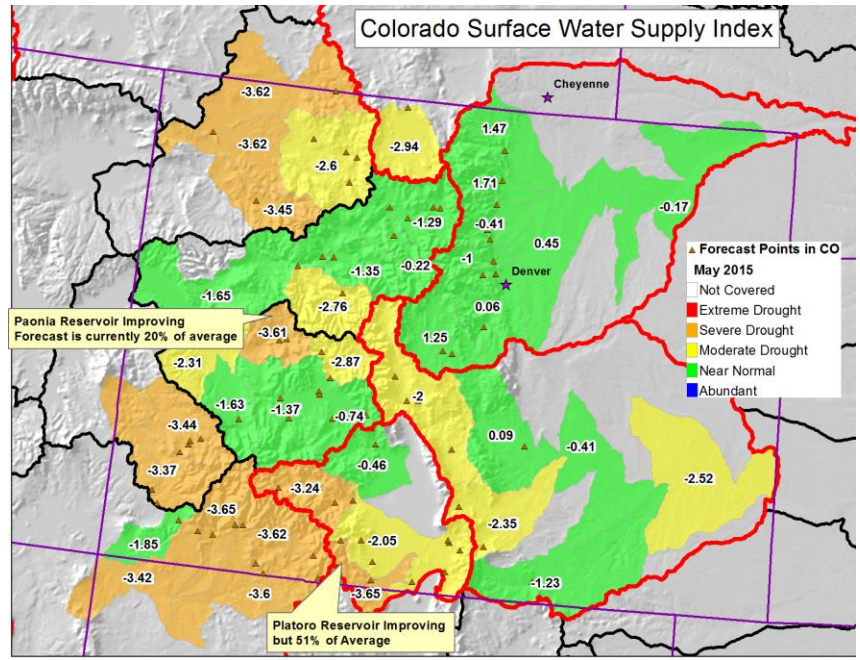


* Repeat! 41 HUCs and 7 river basins.
* Analyze results
* Distribute
  * Colorado Water Supply Conditions Update (DWR)
  * Governor's Water Availability Task Force

A brief history



COLORADO DROUGHT MITIGATION AND RESPONSE PLAN



SWSI Automation Project

* **Goal: Utilize TSTool to run SWSI calculations for Colorado through a transparent, automated process**
* Phase I: Completed Summer 2014
  * TSTool program that closely mirrored existing excel spreadsheets
  * Lessons learned: Need greater ability to handle input data issues
* Phase II: Completed Summer 2015
  * Evaluated alternative river forecasting options
  * Tools to address data input issues
  * User-friendly operating environment
  * Enhanced program verifications/checks
  * Enhanced output files

SWSI Automation Tool

* Takes advantage of new TSTool-Excel integration features.
* User sets up Excel workbook, then runs TSTool steps.

TSTool Configuration Property Name		Property Value	Property Value (Text)	Property Description
CurrentMonthDate	=	2015-09	2015-09	Current month (as date) for which SWSI is being computed. The
CurrentMonth	=	9	09	Current month (as month number 1-12, where 1=January).
PreviousMonthDate	=	2015-08	2015-08	Previous month (as date). The date format YYYY-MM is consiste
PreviousYearMonthDate	=	2014-09	2014-09	Previous year (as date). This date is used in the SWSI output re

F	G	H	I	J	K	L	M
Data Type	ID	Station Name	State	Datastore	Datastore ID	Datastore Source	Datastore Data Type
ForecastedNaturalFlow	06707500	SOUTH PLATTE RIVER AT SOUTH PLATTE	CO	NrcsAwdb	CO-06707500	USGS	SRVO
ForecastedNaturalFlow	06710385	BEAR CREEK ABV EVERGREEN	CO	NrcsAwdb	CO-06710385	USGS	SRVO
ForecastedNaturalFlow	06719505	CLEAR CREEK AT GOLDEN	CO	NrcsAwdb	CO-06719505	USGS	SRVO
ForecastedNaturalFlow	06724000	SAINT VRAIN CREEK AT LYONS	CO	NrcsAwdb	CO-06724000	USGS	SRVO
ForecastedNaturalFlow	06727000	BOULDER CREEK NEAR ORODELL	CO	NrcsAwdb	CO-06727000	USGS	SRVO
ForecastedNaturalFlow	06729500	SOUTH BOULDER CK NR ELDORADO SPRINGS, CO	CO	NrcsAwdb	CO-06729500	USGS	SRVO
ForecastedNaturalFlow	06738000	BIG THOMPSON R AT MOUTH, NR DRAKE, CO	CO	NrcsAwdb	CO-06738000	USGS	SRVO
ForecastedNaturalFlow	06752000	CACHE LA POUDRE R AT CANYON MOUTH	CO	NrcsAwdb	CO-06752000	USGS	SRVO

SWSI TSTool Process

* Download data using web services: NRCS AWDB, ColoradoWaterSMS, ColoradoWaterHBGuest
* Fill data and propagate flags
* Calculate SWSI values based on 2010 Drought Plan
* Create output files that can be used for reports and integration into Hydrobase, CIM, and CDSS Map Viewer

Time Period	Components
January - June	Forecasted Runoff + Reservoir Storage
July - September	Previous Month's Streamflow + Reservoir Storage
October - December	Reservoir Storage

Results

Basin Summary

Basin	Date	SWSI	NEP	SWSI_Prev_Mo	Chg_SWSI_Prev_Mo	SWSI_Prev_Yr	Chg_SWSI_Prev_Yr
Arkansas	2015-08	3.48	91.79	3.77	-0.28	0.05	3.43
Colorado	2015-08	0.30	53.66	2.12	-1.82	0.61	-0.30
Gunnison	2015-08	1.94	73.25	2.55	-0.61	-0.59	2.53
Rio Grande	2015-08	1.33	65.94	1.60	-0.27	-0.32	1.65
San Juan-Dolores	2015-08	2.52	80.26	2.54	-0.02	-1.58	4.10
South Platte	2015-08	3.66	93.95	3.95	-0.29	3.65	0.01
Yampa-White	2015-08	0.27	53.21	-0.67	0.94	0.45	-0.18

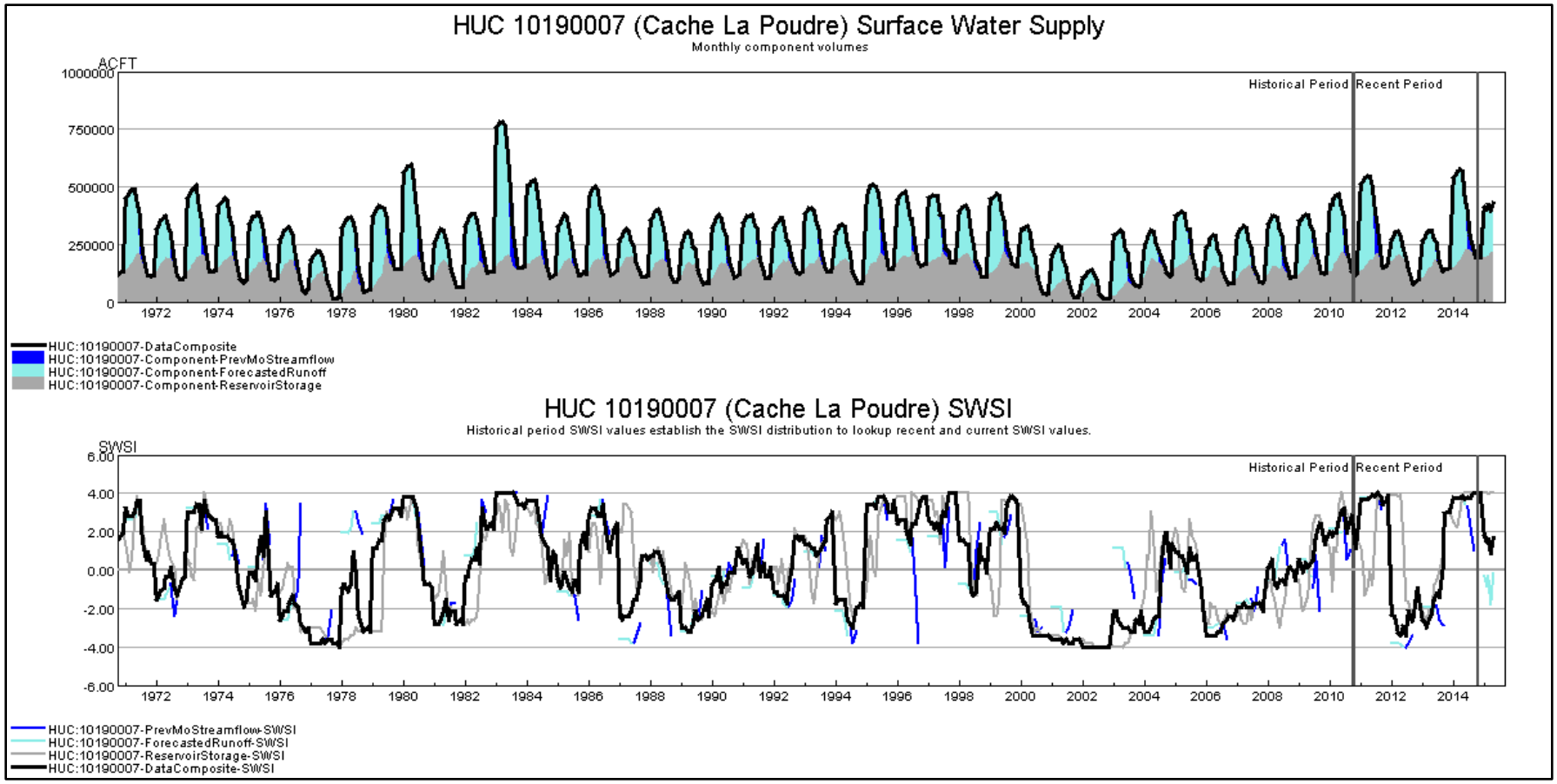
HUC Summary

Basin	HUC_ID	HUC_Name	Date	SWSI	NEP	SWSI_Prev_Yr	Chg_SWSI_Prev_Yr	ReservoirStorageNEP	PrevMoStreamflowNEP	ForecastedRunoffNEP
Arkansas	11020001	Arkansas Headwaters	2015-08	3.04	86.43	-0.78	3.81	73.03	79.85	
Arkansas	11020002	Upper Arkansas	2015-08	3.09	87.03	1.70	1.39	81.89	83.19	
Arkansas	11020005	Upper Arkansas-Lake Meredith	2015-08	3.30	89.63	0.41	2.89	98.51	82.82	

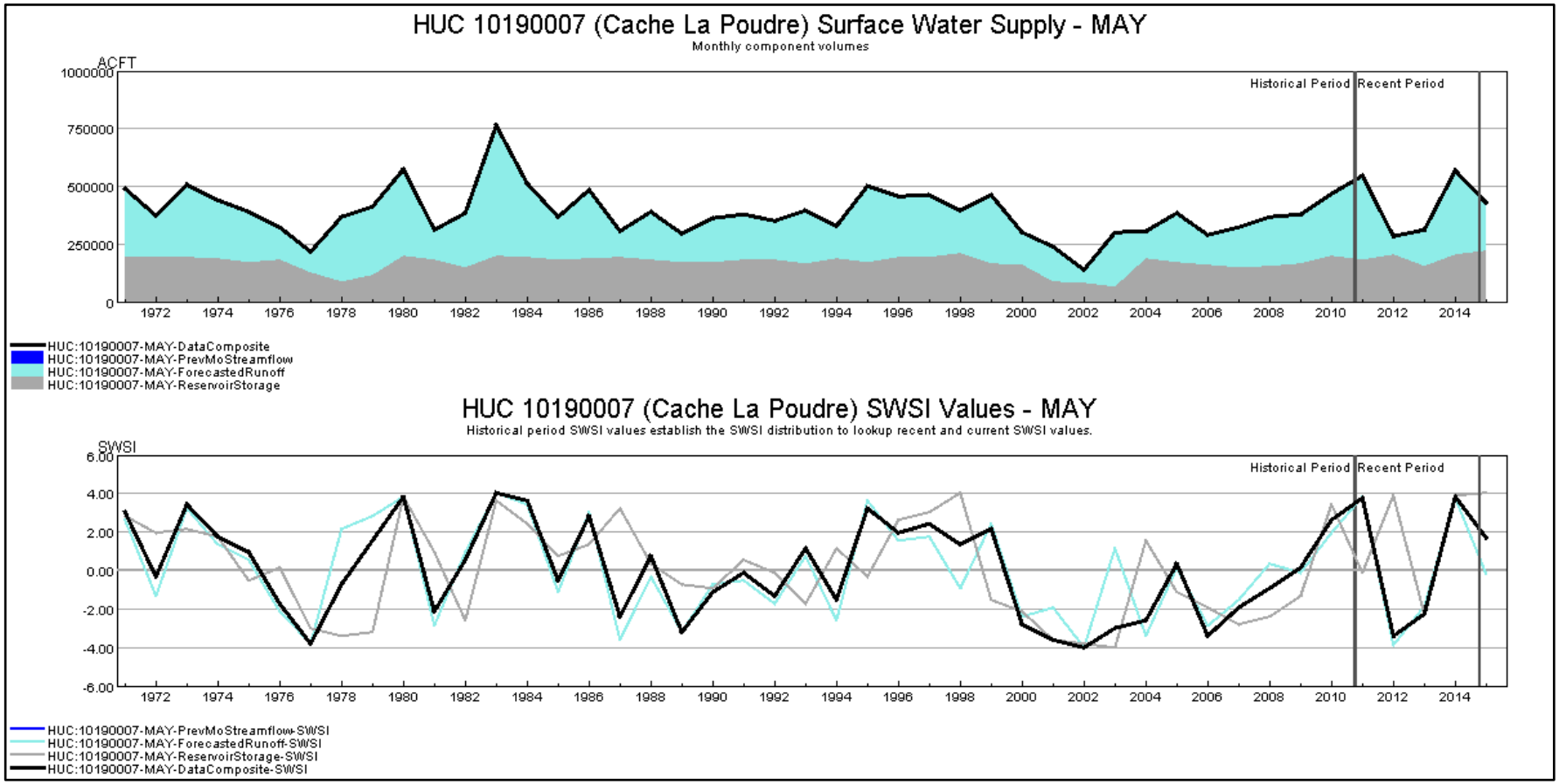
Component Summary

Basin	HUC_ID	HUC_Name	Date	Component Type	Component ID	Component Name	Component Volume	Component NEP by Month
Arkansas	11020001	Arkansas Headwaters	2015-08	PrevMoStreamflow	07091500	ARKANSAS RIVER AT SALIDA	88305.92	79.85
Arkansas	11020001	Arkansas Headwaters	2015-08	ReservoirStorage	07007020	CLEAR CREEK RESERVOIR	9000.00	63.68
Arkansas	11020001	Arkansas Headwaters	2015-08	ReservoirStorage	07007110	TURQUOISE LAKE	120300.00	57.27
Arkansas	11020001	Arkansas Headwaters	2015-08	ReservoirStorage	07007120	TWIN LAKES RESERVOIR	70100.00	66.49
Arkansas	11020001	Arkansas Headwaters	2015-08	ReservoirStorage	09009040	HOMESTAKE RESERVOIR	42500.00	78.61
Arkansas	11020002	Upper Arkansas	2015-08	PrevMoStreamflow	07099400	PUEBLO RESERVOIR INFLOW	136126.69	83.19

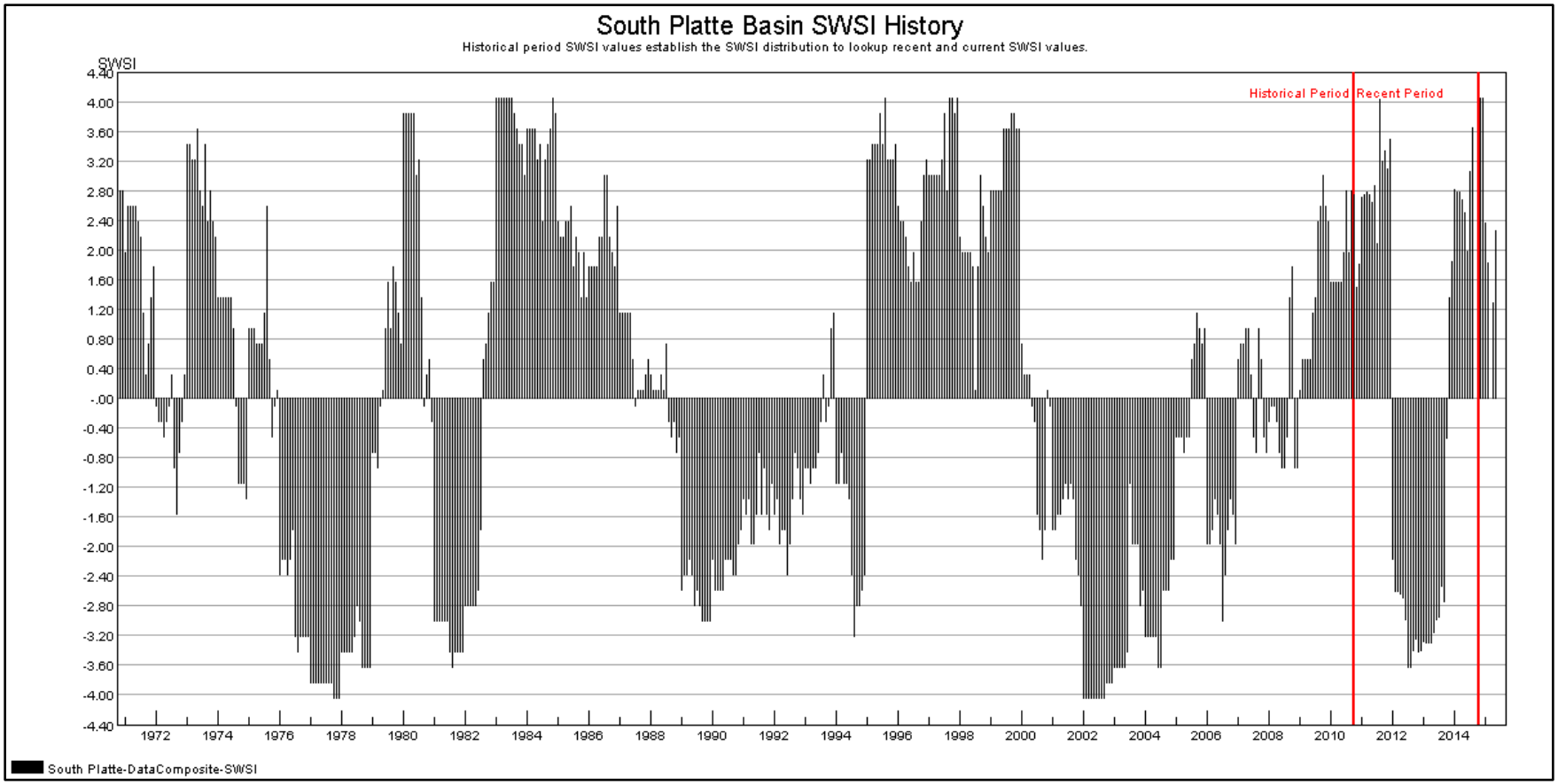
Results


HUC 10190007 (Cache La Poudre) Surface Water Supply
Monthly component volumes
ACFT
1000000
750000
500000
250000
0
Historical Period
Recent Period
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
HUC:10190007-DataComposite
HUC:10190007-Component-PrevMoStreamflow
HUC:10190007-Component-ForecastedRunoff
HUC:10190007-Component-ReservoirStorage
HUC 10190007 (Cache La Poudre) SWSI
Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.
SWSI
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
Historical Period
Recent Period
HUC:10190007-PrevMoStreamflow-SWSI
HUC:10190007-ForecastedRunoff-SWSI
HUC:10190007-ReservoirStorage-SWSI
HUC:10190007-DataComposite-SWSI

Results


HUC 10190007 (Cache La Poudre) Surface Water Supply - MAY
Monthly component volumes
ACFT
1000000
750000
500000
250000
0
Historical Period
Recent Period
1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
HUC:10190007-MAY-DataComposite
HUC:10190007-MAY-PrevMoStreamflow
HUC:10190007-MAY-ForecastedRunoff
HUC:10190007-MAY-ReservoirStorage
HUC 10190007 (Cache La Poudre) SWSI Values - MAY
Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.
SWSI
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
Historical Period
Recent Period
1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
HUC:10190007-MAY-PrevMoStreamflow-SWSI
HUC:10190007-MAY-ForecastedRunoff-SWSI
HUC:10190007-MAY-ReservoirStorage-SWSI
HUC:10190007-MAY-DataComposite-SWSI

Results


South Platte Basin SWSI History
Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.
SWSI
Historical Period
Recent Period
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
-.00
-0.40
-0.80
-1.20
-1.60
-2.00
-2.40
-2.80
-3.20
-3.60
-4.00
-4.40
1972
1974
1976
1978
1980
1982
1984
1986
1988
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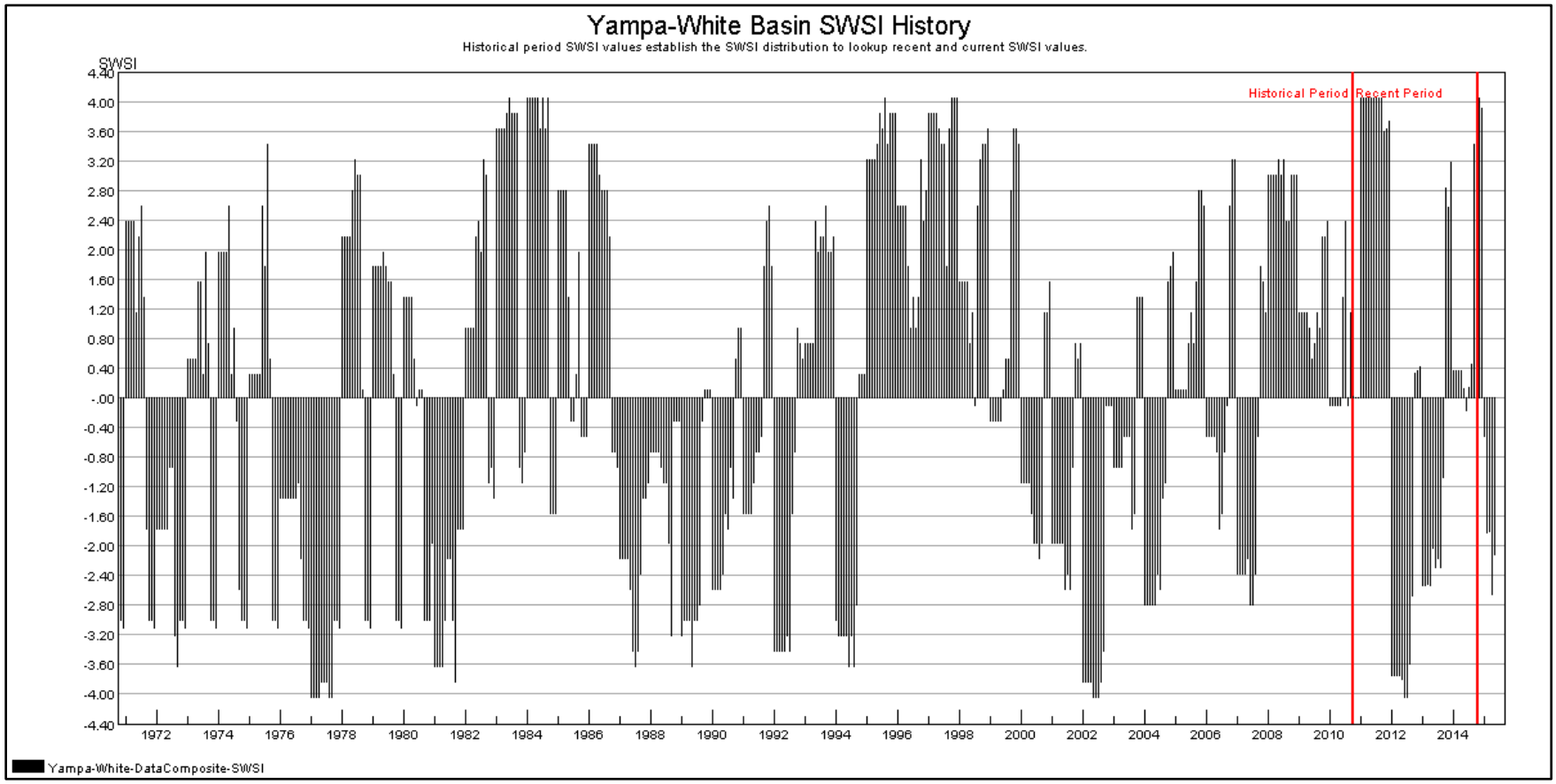
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
South Platte-DataComposite-SWSI

Results


Yampa-White Basin SWSI History
Historical period SWSI values establish the SWSI distribution to lookup recent and current SWSI values.
SWSI
Historical Period
Recent Period
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
1.20
0.80
0.40
-.00
-0.40
-0.80
-1.20
-1.60
-2.00
-2.40
-2.80
-3.20
-3.60
-4.00
-4.40
1972
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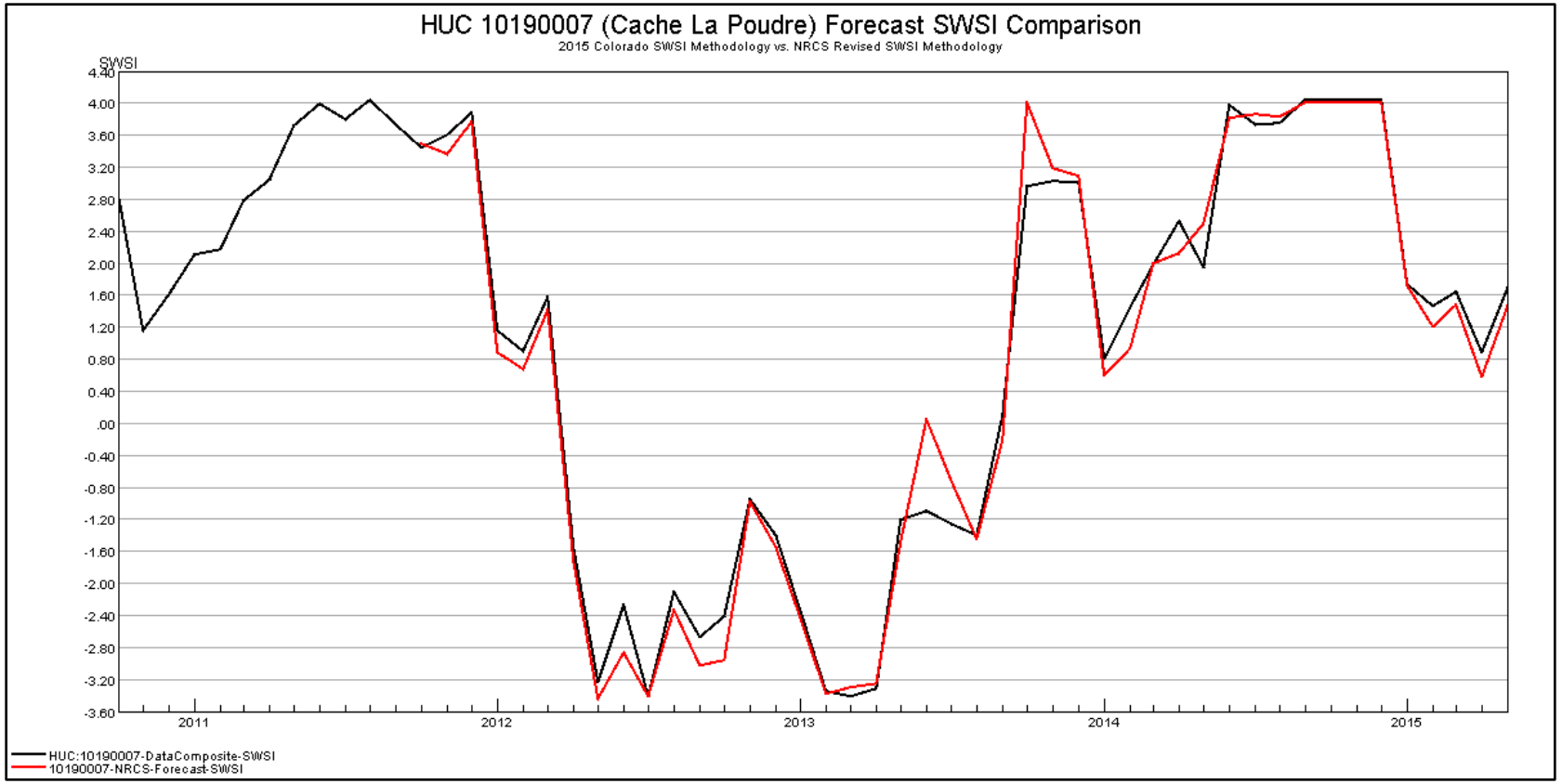
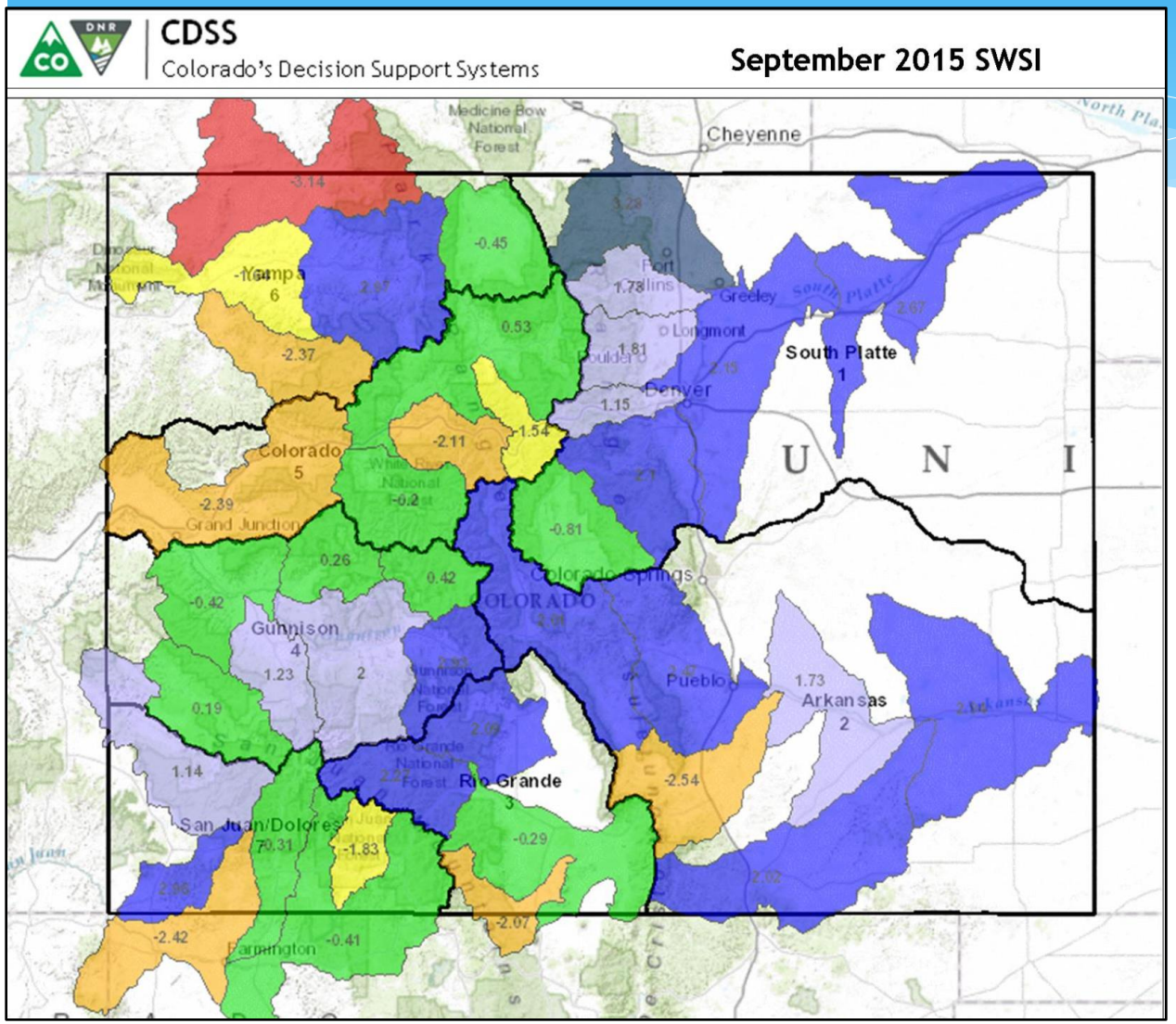
2014
Yampa-White-DataComposite-SWSI

Program Verification



Automated SWSI Tool Highlights



SWSI Legend:

>= +3, Dark Grey
- Abundant Supply

+2 to +2.9, Dark Blue
- Very Wet

+1 to +1.9, Light purple
- Wet

-0.9 to +0.9, Green
- Normal

-1 to -1.9, Yellow
- Dry

-2 to -2.9, Orange
- Very Dry

<=-3, Red
- Extreme Drought

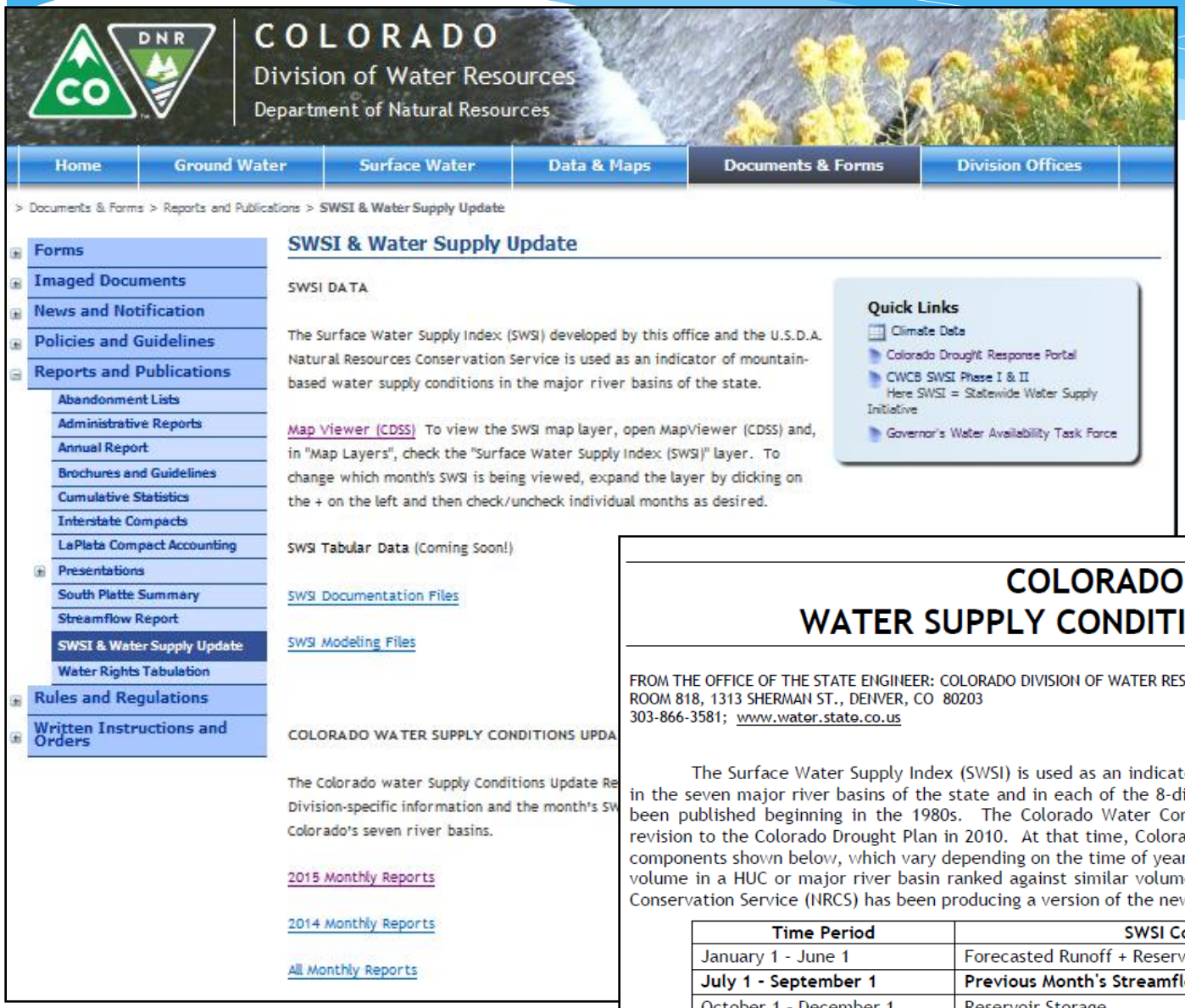
SWSI Integration

* **Laserfiche**
  * Water Supply Update Reports
    * All reports now stored in Laserfiche
  * SWSI documentation
    * Transparent, accessible
  * SWSI monthly modeling files:
    * Ensures transparent, repeatable process
    * No output files/pictures saved, only save input files needed to reproduce outputs
    * No need to store SWSIs on shared drive

SWSI Integration

* **Hydrobase**
  * SWSI Summary output file brought in automatically
  * Sends data sets to the Colorado Information Marketplace for viewing of tabular data by the public
  * Sends data needed for MapViewer (CDSS) update
* **MapViewer (CDSS)**
  * Each HUC will have its SWSI *and* its SWSI components
  * Link to CIM to obtain component details
  * Link to DWR's Water Supply Update, which has graphs

Website & Report



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> Documents & Forms > Reports and Publications > SWSI & Water Supply Update

- Forms
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  - Streamflow Report
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- Written Instructions and Orders

SWSI & Water Supply Update

SWSI DATA

The Surface Water Supply Index (SWSI) developed by this office and the U.S.D.A. Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state.

Map Viewer (CDSS) To view the SWSI map layer, open MapViewer (CDSS) and, in "Map Layers", check the "Surface Water Supply Index (SWSI)" layer. To change which month's SWSI is being viewed, expand the layer by clicking on the + on the left and then check/uncheck individual months as desired.

Quick Links
- Climate Data
- Colorado Drought Response Portal
- CWCB SWSI Phase I & II
  Here SWSI = Statewide Water Supply Initiative
- Governor's Water Availability Task Force

SWSI Tabular Data (Coming Soon!)

SWSI Documentation Files

SWSI Modeling Files

COLORADO WATER SUPPLY CONDITIONS UPDA

The Colorado water Supply Conditions Update Re
Division-specific information and the month's SW
Colorado's seven river basins.

2015 Monthly Reports

2014 Monthly Reports

All Monthly Reports

COLORADO
WATER SUPPLY CONDITIONS UPDATE

FROM THE OFFICE OF THE STATE ENGINEER: COLORADO DIVISION OF WATER RESOURCES
ROOM 818, 1313 SHERMAN ST., DENVER, CO 80203
303-866-3581; www.water.state.co.us

August 1, 2015

The Surface Water Supply Index (SWSI) is used as an indicator of mountain-based water supply conditions in the seven major river basins of the state and in each of the 8-digit HUC basins. Colorado's original SWSI was been published beginning in the 1980s. The Colorado Water Conservation Board (CWCB) completed a major revision to the Colorado Drought Plan in 2010. At that time, Colorado adopted a new SWSI analysis based on the components shown below, which vary depending on the time of year. The new SWSI is based on a ranking of total volume in a HUC or major river basin ranked against similar volumes in historical years. The Natural Resources Conservation Service (NRCS) has been producing a version of the new SWSI for the last few years.

Time Period	SWSI Components
January 1 - June 1	Forecasted Runoff + Reservoir Storage
July 1 - September 1	**Previous Month's Streamflow + Reservoir Storage**
October 1 - December 1	Reservoir Storage

Next Steps

* Finish SWSI Integration
* Coordinate publication of SWSI with NRCS
* Continue vetting data, developing native flow calculations, and developing internal documentation
* Open Water Foundation's recommendations

Questions?

Special thanks to:

- Open Water Foundation
- CWCB
- Riverside Technology, Inc
- NRCS Snow Survey Colorado
- NRCS National Water and Climate Center
- Northern Water
- Denver Water