Memorandum

To: URGWOM Technical Team Members
Date: June 14, 2021
Subject: Notes of the June 8, 2021 URGWOM Technical Team Meeting

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These notes summarize the items discussed during the June 8, 2021 Upper Rio Grande Water Operations Model (URGWOM) Technical Team meeting. The meeting began at 9:00 am and was conducted as an on-line collaboration hosted by the Corps of Engineers using the Corps' WebEx account. All those participating in the meeting introduced themselves and their names and affiliation are listed on the last page of these meeting notes.

This month's meeting agenda topics include a presentation on an analysis of the Rio Grande at Lobatos streamflow hydrographs, preliminary planning on URGWOM Technical Team field trip site inspections and general updates on ongoing URGWOM related activities from the Corps of Engineers, the Bureau of Reclamation, the US Geological Survey and the Interstate Stream Commission.

Nick reported to the Team on his review and analysis of the development of streamflow hydrographs for the flow of the Rio Grande at Lobatos, CO for use in the URGWOM models. He reported that this work was being undertaken at the request of the Corps of Engineers. He described the two options for the development of the Lobatos hydrographs for use in the AOP runs; the Colorado disabled and the Colorado enabled options.

The Colorado disabled option hydrograph is based on NRCS runoff forecast volumes which are then compared to the historic flows to determine a year of similar forecast volumes and this year is used as the basis for the hydrograph shape. As the runoff period progresses, historic data are brought into the model and only the time remaining in the forecast period is estimated based on the forecast. Annual forecast volumes for flow at Lobatos are no longer being prepared by the NRCS; only the runoff period forecast is published (usually April – July).

The Colorado enabled option hydrograph uses routed forecasted inflows at the upstream index stations and diversion and return flows are simulated. Local inflows downstream of the index gages are estimated. When the model assumes that the routed inflows will be adequate to meet the delivery obligations, Nick found that the flow routed to Lobatos was less than the Compact delivery schedule.

Nick proposed changes to the model that are based on the Colorado Rio Grande Compact delivery schedule. The local inflows downstream of the index inflow stations are based on the flow at the index stations, but the watershed conditions downstream of the index stations could be drier (or wetter) than in the watershed upstream of the index stations which reduces the reliability of the local inflow estimates. Also, the Lobatos streamflow forecast are no longer

necessary and the related initialization rule for this can be deleted. Changes to the Compact curtailment expression slots would be necessary to ensure that irrigation season (April 1 – October 31) diversions are controlled to ensure stateline deliveries. The proposed changes will ensure that the Colorado Compact delivery requirement is met every year. Diversion outside of the irrigation season, e.g., diversions for groundwater recharge until November 15, would require more extensive changes to the model which are not being proposed at this time.

The flow at the index inflow stations (Lobatos and Mogote) used in Planning Model runs are based on the historic data and multi-year hydrologic sequences are developed for streamflow forecasts. Local inflow below the index stations are based on historic correlations with index station forecasted flow. The proposed changes to the model to improve the AOP run Lobatos hydrograph can be applied to Planning Model runs. The implementation of the changes described by Nick would require update of the URGWOM documentation.

Miller briefed the Team on proposed Technical Team field trips. Two single day trips of the Albuquerque and Belen Divisions of the MRGCD are proposed. Miller will circulate a proposed itinerary to the Technical Team of the potential sites to visit on the field trips. It was also proposed to conduct the field trip as a regularly scheduled meeting of the Technical Team. A representative of the MRGCD would accompany the Tech Team to describe the system operations. Carolyn suggested that the Belen Division tour be conducted first before the available irrigation supply is depleted and the system would not be in full operation.

Lucas reported that he has received an inquiry from a former Reclamation colleague who is pursuing a Master's Degree. The colleague is researching the use of multi-spectral imagery data in vegetation indices to determine if this is a viable way to estimate ground water flux in arid soils. Lucas solicited input from Team members as to whether there is value to estimating losses due to groundwater infiltration and possibly to provide a forecast of groundwater flux using this method for potential use in URGWOM. Lucas requested that Team members contact him if there is any interest from Team members in the effort.

Lucas also reported that he has nearly completed the task of adding the Santa Fe River basin and related water resource infrastructure into the URGWOM model being used in the Rio Grande basin study.

Dave stated that the USGS had nothing to report to the Team at this time.

Phillip reported that a representative of the Interstate Stream Commission was unavailable to attend the meeting. Phillip also reported that the review of groundwater object implementation being prepared by Intera is nearly complete and the results would be presented at the next meeting of the Technical Team.

The next regular meeting of the Technical Team is scheduled for July 13, 2021 at 9:00 am, which will also be an on-line collaboration.

There being no other business, the meeting adjourned at approximately 9:50 am.

ATTENDANCE LIST
URGWOM TECHNICAL TEAM MEETING
June 8, 2021

NAME	REPRESENTING
Phillip Carrillo	USACE
William Miller	Southwest Water Design/USACE Contractor
Mike Brown	Tetra Tech/USACE Contractor
Dave Moeser	US Geological Survey
Lucas Barrett	Bureau of Reclamation
Michele Estrada Lopez	Bureau of Reclamation
Andrew Gelderloos	Bureau of Reclamation
Jerry Melendez	Bureau of Reclamation
Andrew Gelderloos	Bureau of Reclamation
Carolyn Donnelly	Bureau of Reclamation
David Neumann	CADSWES
Rick Shean	Albuquerque Bernalillo County Water Utility
Diane Agnew	Albuquerque Bernalillo County Water Utility
Nick Mander	Hydros Consulting
Zhuping Sheng	Paso del Norte Watershed Council
Suzy Valentine	Texas Rio Grande Compact Commission

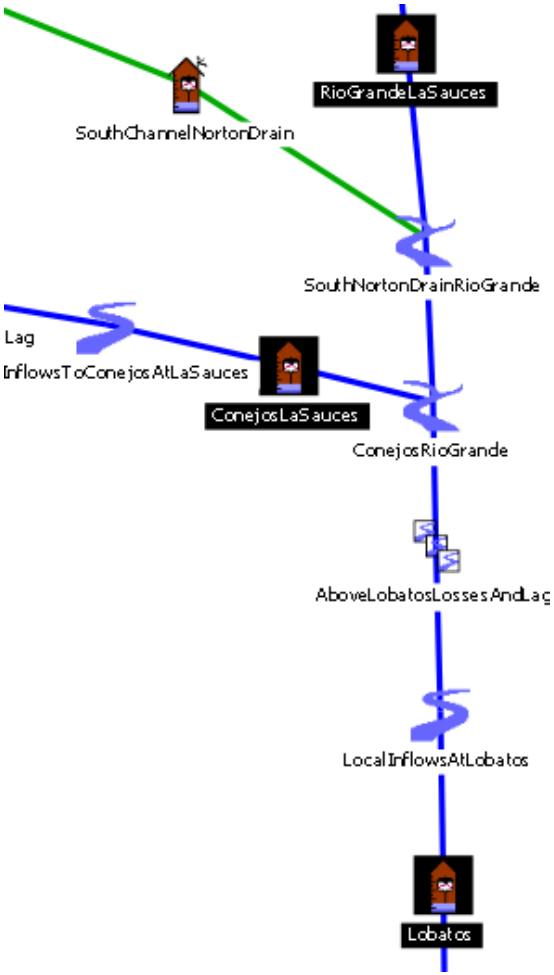
Analysis of Lobatos hydrograph computation in URGWOM

Hydros Consulting Inc.
June 8, 2021

Purpose

- USACE requested that Hydros Consulting Inc. do the following:

1. Explain the hydrograph that shows up at Lobatos in URGWOM AOP and Planning runs.
2. Explain when LocalInflows, other than the values computed by URGWOM, would need to be used in URGWOM AOP and Planning runs.

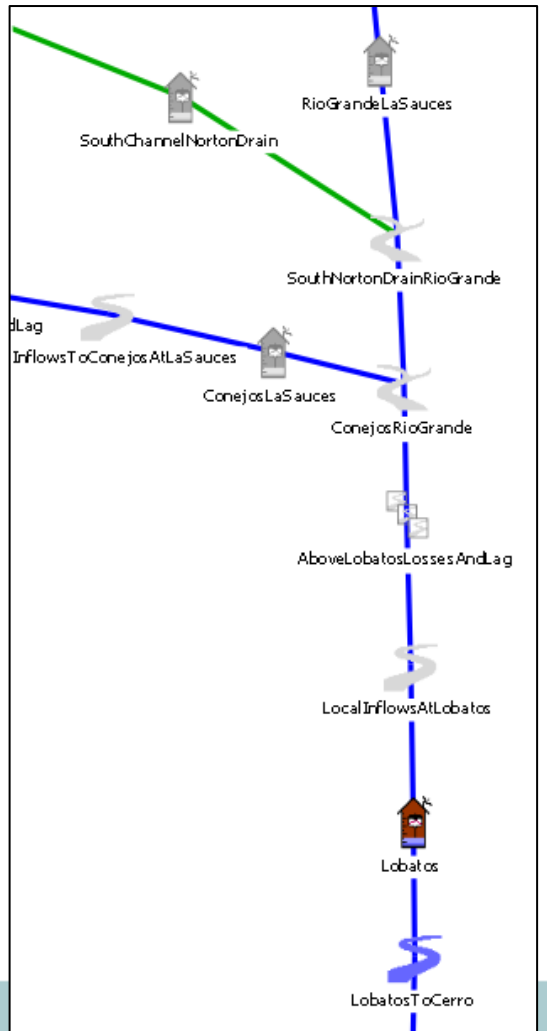


Outline

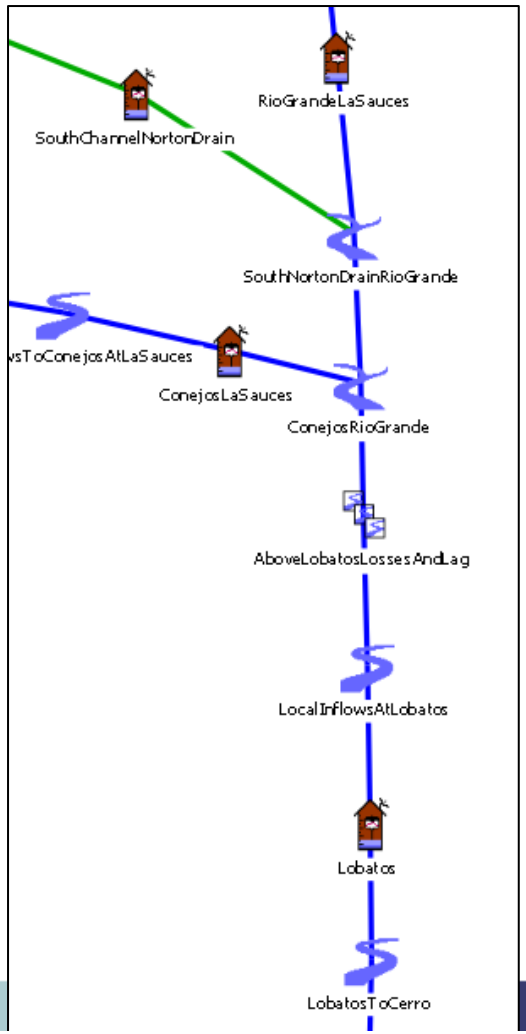
1) Lobatos hydrograph in AOP run when Colorado disabled
2) Lobatos forecast computation
   i. Proposed change to Lobatos forecast computation
   ii. Is Lobatos forecast even needed in model?
3) Colorado Compact Curtailment
   i. Proposed change to Lobatos compact curtailment computation
4) Conclusion

Two types of AOP runs

1) Colorado portion of URGWOM disabled



2) Colorado portion of URGWOM enabled



AOP Run with Colorado Disabled

1) The model user must input a Lobatos NRCS forecast for the runoff season (April through July) and for the entire year:

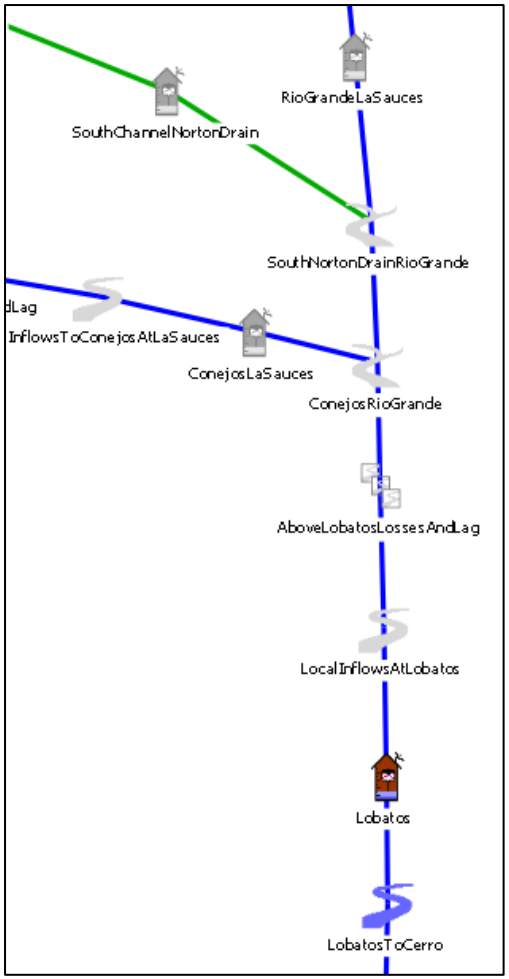
InputForecastData.ForecastsApril

File Edit Row Column View Adjust

ForecastsApril

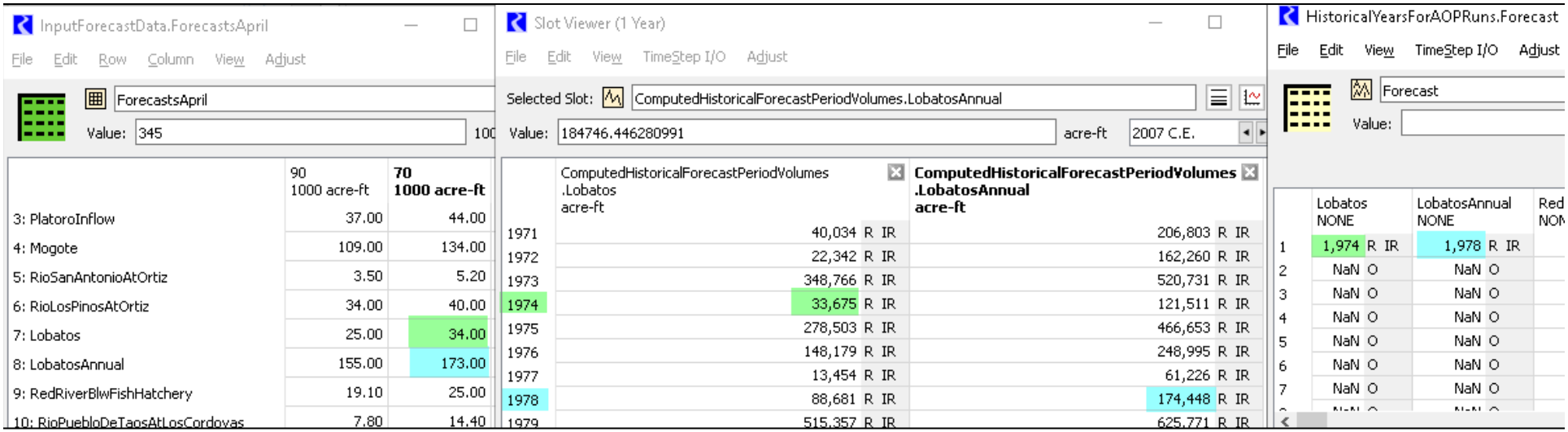
Value: 270

	90 1000 acre-ft	70 1000 acre-ft	50 1000 acre-ft	%Avg percent	30 1000 acre-ft	10 1000 acre-ft
0: ThirtyMileBridge	54.00	73.00	87.00	67	102.00	127.00
1: WagonWheelGap	150.00	200.00	240.00	71	280.00	350.00
2: SouthFork	66.00	82.00	93.00	73	105.00	124.00
3: PlatoroInflow	37.00	44.00	50.00	81	56.00	65.00
4: Mogote	109.00	134.00	153.00	79	173.00	205.00
5: RioSanAntonioAtOrtiz	3.50	5.20	6.50	42	8.00	10.50
6: RioLosPinosAtOrtiz	34.00	42.00	48.00	66	55.00	65.00
7: Lobatos	62.00	75.80	87.00	40	98.00	124.00
8: LobatosAnnual	155.00	173.00	199.00	40	225.00	270.00
9: RedRiverBluFishHatchery	19.10	25.00	29.00	85	34.00	42.00



AOP Run with Colorado Disabled

2) The model matches these 2 NRCS forecasts with the closest historical years



InputForecastData.ForecastsApril

File Edit Row Column View Adjust

ForecastsApril

Value: 345

	90 1000 acre-ft	**70** **1000 acre-ft**
3: PlatoroInflow	37.00	44.00
4: Mogote	109.00	134.00
5: RioSanAntonioAtOrtiz	3.50	5.20
6: RioLosPinosAtOrtiz	34.00	40.00
7: Lobatos	25.00	34.00
8: LobatosAnnual	155.00	173.00
9: RedRiverBlwFishHatchery	19.10	25.00
10: RioPuebloDeTaosAtLosCordovas	7.80	14.40

Slot Viewer (1 Year)

File Edit View TimeStep I/O Adjust

Selected Slot: ComputedHistoricalForecastPeriodVolumes.LobatosAnnual

Value: 184746.446280991 acre-ft 2007 C.E.

	ComputedHistoricalForecastPeriodVolumes .Lobatos acre-ft	**ComputedHistoricalForecastPeriodVolumes** **.LobatosAnnual** **acre-ft**
1971	40,034 R IR	206,803 R IR
1972	22,342 R IR	162,260 R IR
1973	348,766 R IR	520,731 R IR
1974	33,675 R IR	121,511 R IR
1975	278,503 R IR	466,653 R IR
1976	148,179 R IR	248,995 R IR
1977	13,454 R IR	61,226 R IR
1978	88,681 R IR	174,448 R IR
1979	515,357 R IR	625,771 R IR

HistoricalYearsForAOPRuns.Forecast

File Edit View TimeStep I/O Adjust

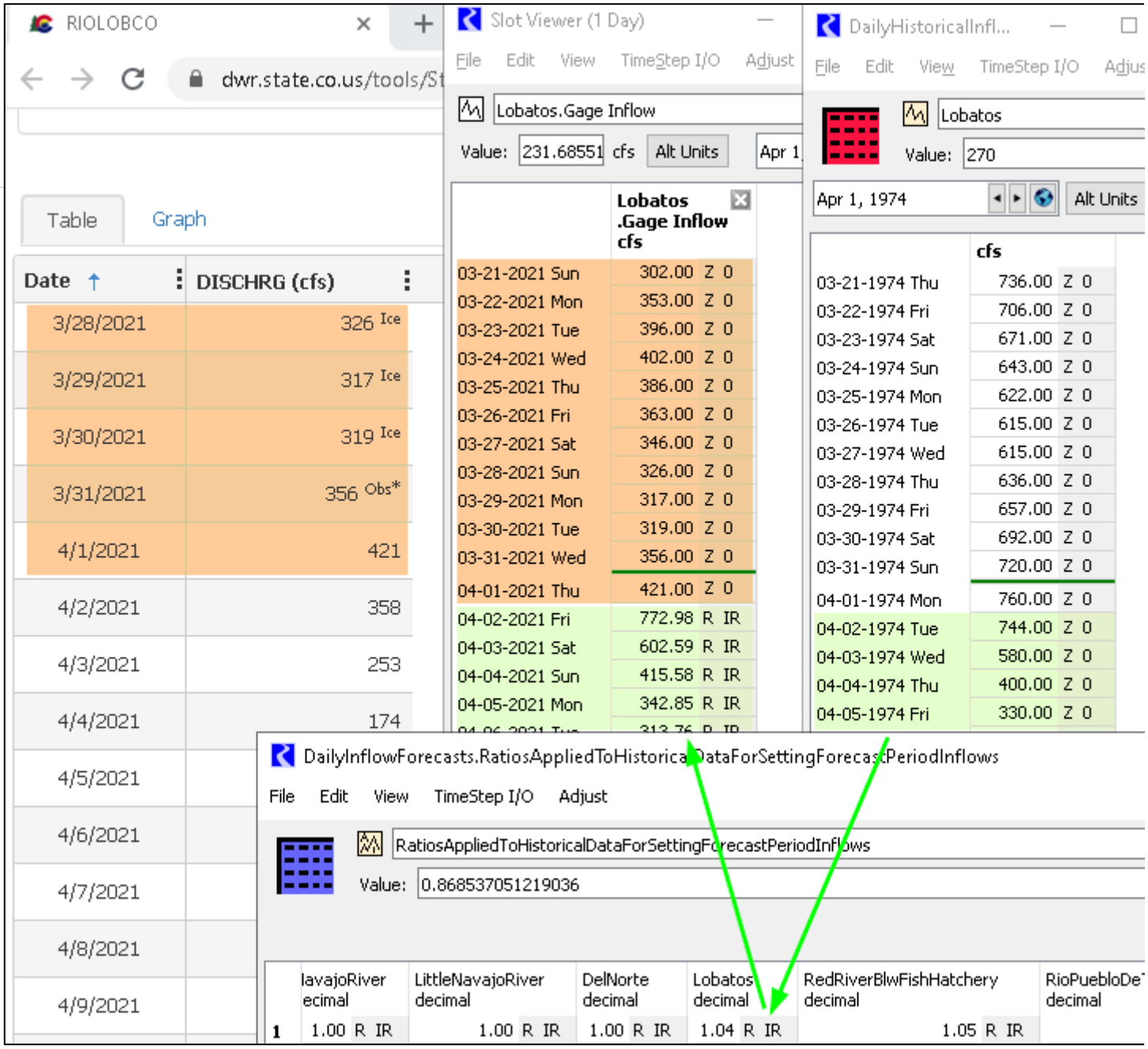
Forecast

Value:

	Lobatos NONE	LobatosAnnual NONE	Red NON
1	1,974 R IR	1,978 R IR	
2	NaN O	NaN O	
3	NaN O	NaN O	
4	NaN O	NaN O	
5	NaN O	NaN O	
6	NaN O	NaN O	
7	NaN O	NaN O	

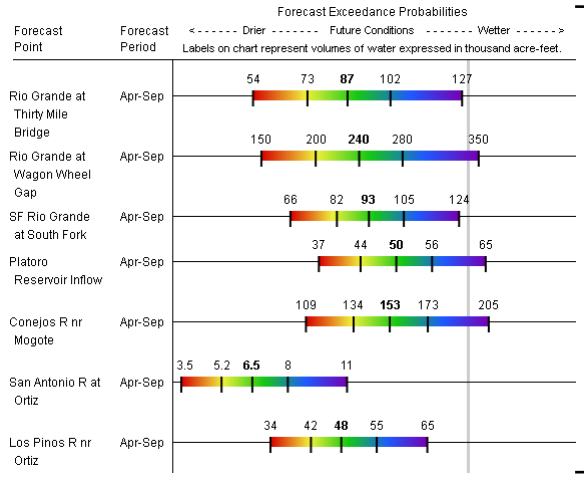
AOP Run with Colorado Disabled

3) The hydrograph that arrives at Lobatos is the gaged hydrograph year-to-date, and then a scaled hydrograph from the matched historical year

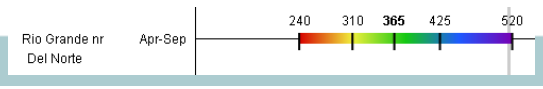


AOP Run with Colorado Disabled

- NRCS doesn't usually release a Lobatos forecast (probably because the flow at Lobatos is dependent on CO diversions). The Forecast I used earlier was made up
- Therefore, running URGWOM with Colorado disabled is often not possible



UPPER RIO GRANDE	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Red R bl Fish Hatchery nr Questa	APR-JUL	15.3	23	28	117%	35	45	24
	MAR-JUL	19.1	25	29	85%	34	42	34
	APR-JUL	16.8	23	27	87%	32	40	31
Rio Pueblo de Taos nr Taos	MAR-JUL	6.8	9.8	12.2	72%	14.9	19.3	17
	APR-JUL	6.1	9.1	11.5	72%	14.2	18.6	15.9
Embudo Ck at Dixon	MAR-JUL	6.9	14	20	42%	28	42	48
	APR-JUL	5.5	12.6	19	43%	27	41	44
Rio Grande at Otowi Bridge [2]	MAR-JUL	255	345	415	58%	490	620	720
	APR-JUL	210	300	370	58%	445	575	635



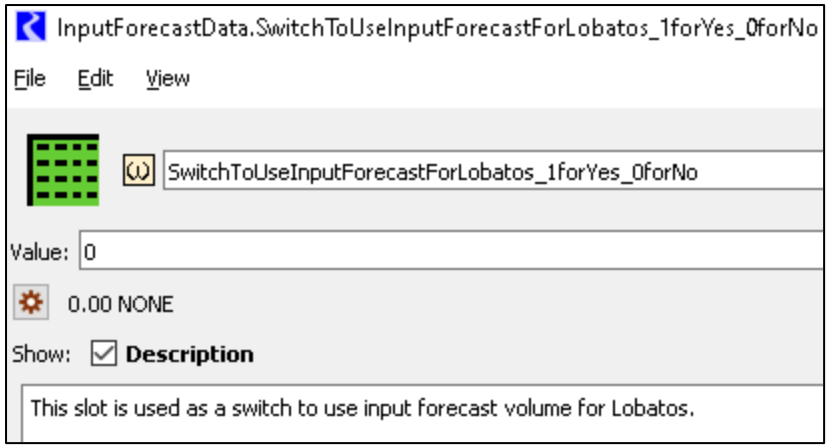
ForecastsApril

Value:

	90 1000 acre-ft	70 1000 acre-ft	50 1000 acre-ft	%Avg percent	30 1000 acre-ft	10 1000 acre-ft
0: ThirtyMileBridge	54.00	73.00	87.00	67	102.00	127.00
1: WagonWheelGap	150.00	200.00	240.00	71	280.00	350.00
2: SouthFork	66.00	82.00	93.00	73	105.00	124.00
3: PlatoroInflow	37.00	44.00	50.00	81	56.00	65.00
4: Mogote	109.00	134.00	153.00	79	173.00	205.00
5: RioSanAntonioAtOrtiz	3.50	5.20	6.50	42	8.00	10.50
6: RioLosPinosAtOrtiz	34.00	40.00	48.00	66	55.00	65.00
7: Lobatos	NaN	NaN	NaN	NaN	NaN	NaN
8: LobatosAnnual	NaN	NaN	NaN	NaN	NaN	NaN
9: RedRiverBlwFishHatchery	19.10	25.00	29.00	85	34.00	42.00
10: RioPuebloDeTaosAtLosCordovas	7.80	14.40	20.00	61	27.00	38.00
11: EmbudoCreekAtDixon	6.90	14.00	20.00	42	28.00	42.00
12: Otowi	255.00	345.00	415.00	58	490.00	620.00
13: NrJemez	5.90	8.80	11.20	27	14.00	18.70
14: TotalJemezInflow	1.80	4.00	6.20	18	9.00	14.10
15: ElVadoInflow	72.00	97.00	116.00	52	137.00	171.00
16: RioBlanco	28.00	35.00	40.00	74	46.00	55.00
17: NavajoRiver	31.00	39.00	45.00	69	51.00	62.00
18: DelNorte	240.00	310.00	365.00	71	425.00	520.00

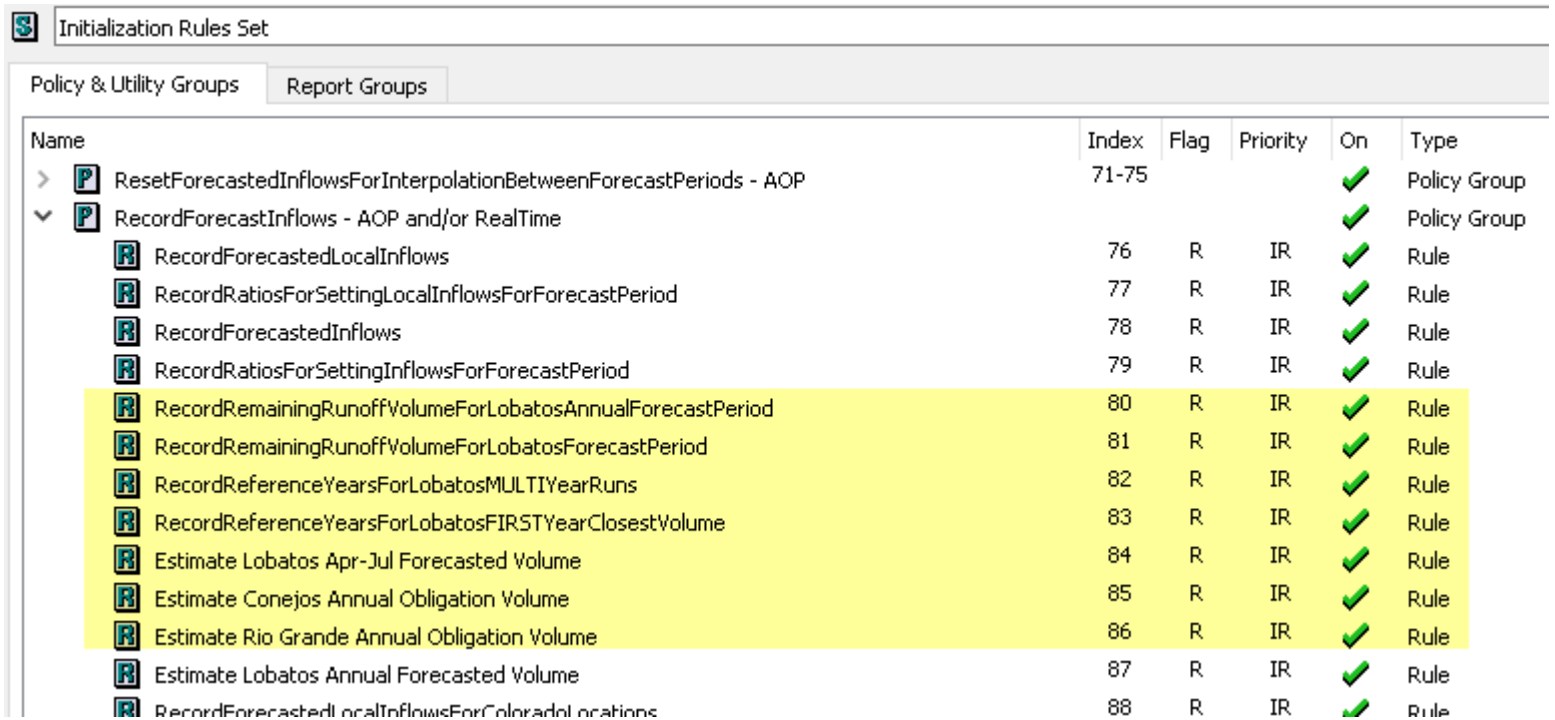
AOP run with Colorado Enabled

- With Colorado enabled, the hydrograph at Lobatos is based on Colorado forecasted inflows and the Rio Grande Compact.
- Since NRCS usually doesn't release a Forecast for Lobatos, the following switch is usually set to 0 in AOP runs, and a Lobatos forecast is computed by URGWOM



AOP run with Colorado Enabled

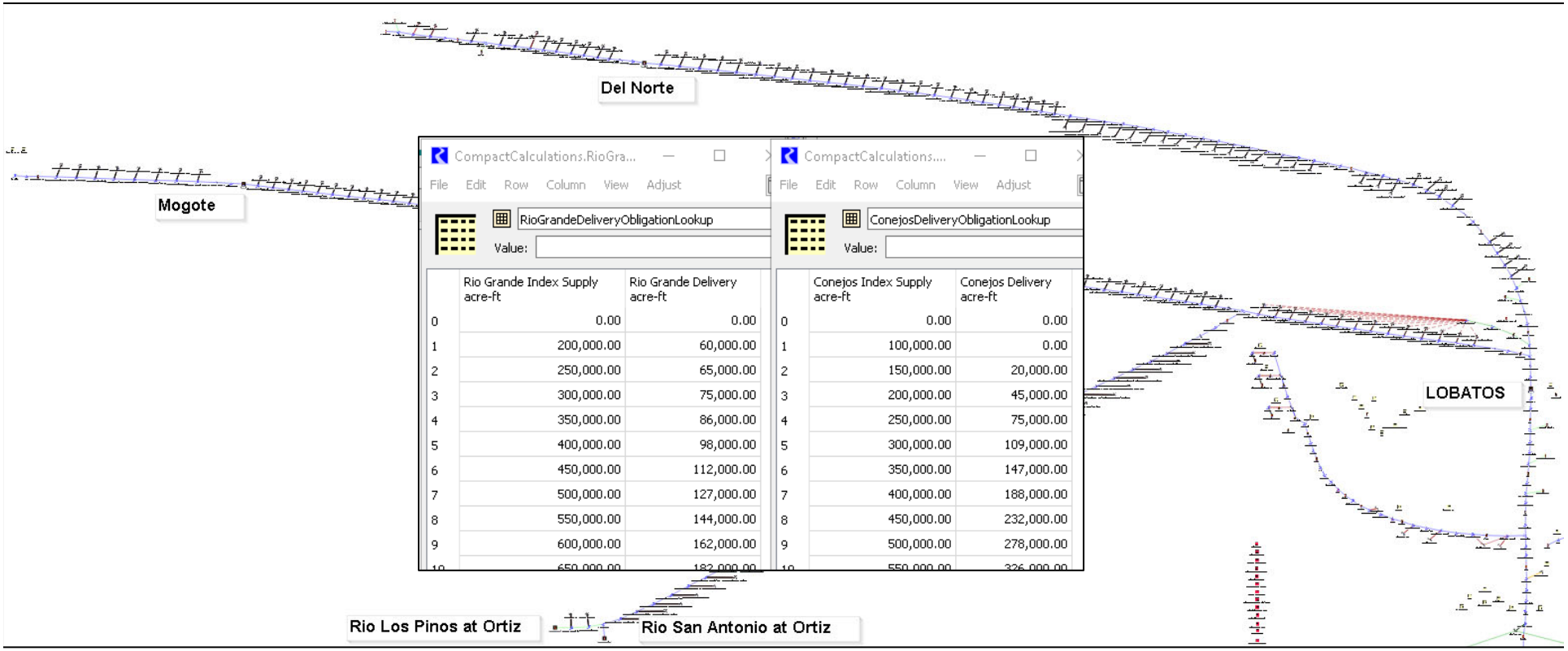
- Several Initialization rules compute a Forecast for Lobatos:



Name	Index	Flag	Priority	On	Type
ResetForecastedInflowsForInterpolationBetweenForecastPeriods - AOP	71-75			✓	Policy Group
RecordForecastInflows - AOP and/or RealTime				✓	Policy Group
RecordForecastedLocalInflows	76	R	IR	✓	Rule
RecordRatiosForSettingLocalInflowsForForecastPeriod	77	R	IR	✓	Rule
RecordForecastedInflows	78	R	IR	✓	Rule
RecordRatiosForSettingInflowsForForecastPeriod	79	R	IR	✓	Rule
RecordRemainingRunoffVolumeForLobatosAnnualForecastPeriod	80	R	IR	✓	Rule
RecordRemainingRunoffVolumeForLobatosForecastPeriod	81	R	IR	✓	Rule
RecordReferenceYearsForLobatosMULTIYearRuns	82	R	IR	✓	Rule
RecordReferenceYearsForLobatosFIRSTYearClosestVolume	83	R	IR	✓	Rule
Estimate Lobatos Apr-Jul Forecasted Volume	84	R	IR	✓	Rule
Estimate Conejos Annual Obligation Volume	85	R	IR	✓	Rule
Estimate Rio Grande Annual Obligation Volume	86	R	IR	✓	Rule
Estimate Lobatos Annual Forecasted Volume	87	R	IR	✓	Rule
RecordForecastedLocalInflowsForColoradoLocations	88	R	IR	✓	Rule

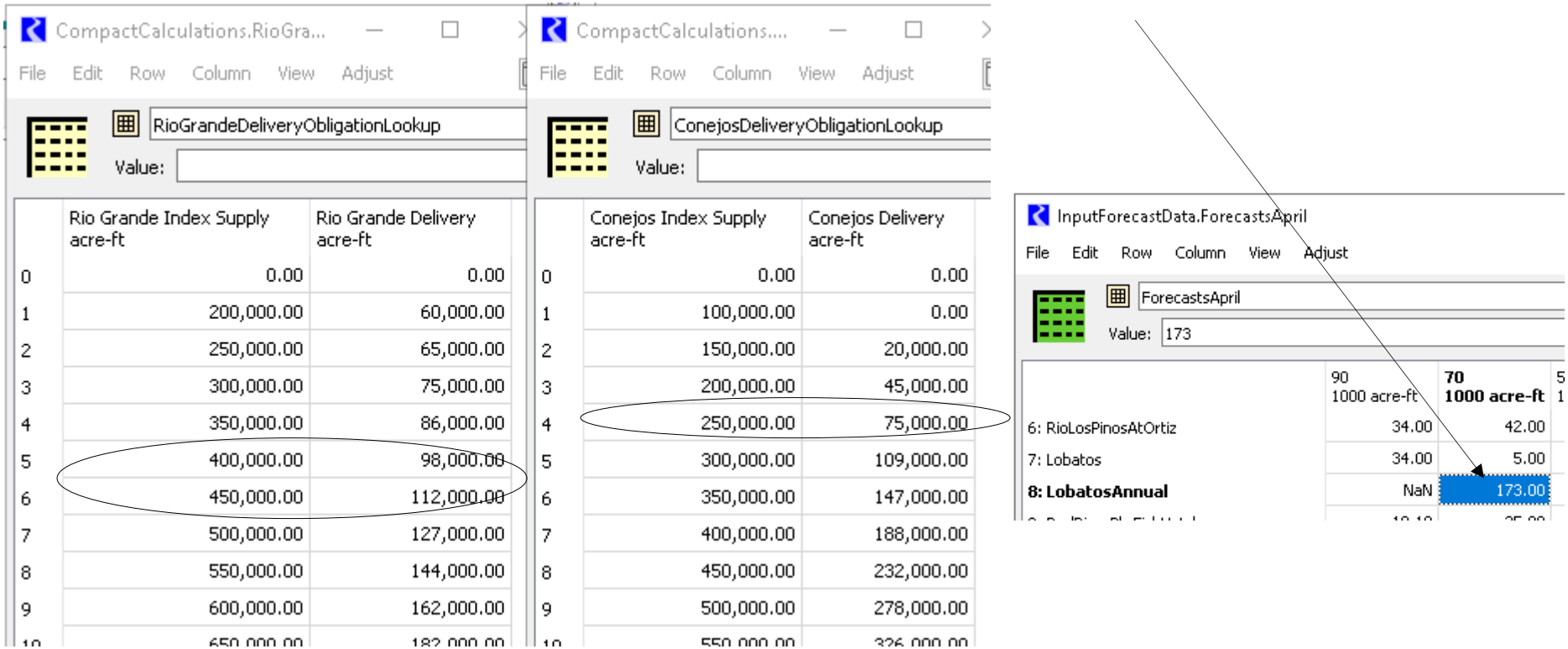
AOP run with Colorado Enabled

- This Lobatos forecast is based on the forecasted flow at: Rio Grande at Del Norte, Conejos at Mogote, Rio Los Pinos at Ortiz, and Rio San Antonio at Ortiz, and the Compact obligation tables



AOP run with Colorado Enabled

- E.g., in 2021, the 70% annual forecast for Del Norte is 424 KAF and the 70% annual Forecast for the Conejos is 255 KAF, so the Lobatos Annual forecast computed by URGWOM is 105 + 78 = 183 (minus a 10 KAF adjustment)



	Rio Grande Index Supply acre-ft	Rio Grande Delivery acre-ft
0	0.00	0.00
1	200,000.00	60,000.00
2	250,000.00	65,000.00
3	300,000.00	75,000.00
4	350,000.00	86,000.00
5	400,000.00	98,000.00
6	450,000.00	112,000.00
7	500,000.00	127,000.00
8	550,000.00	144,000.00
9	600,000.00	162,000.00

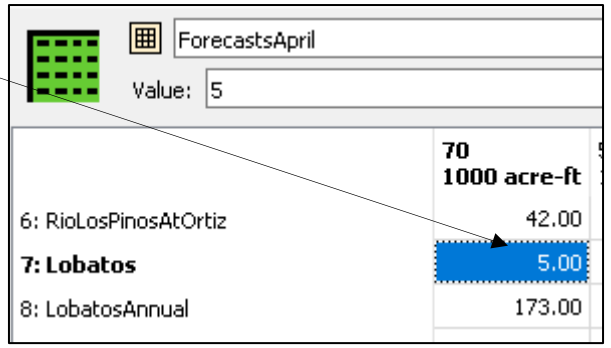
	Conejos Index Supply acre-ft	Conejos Delivery acre-ft
0	0.00	0.00
1	100,000.00	0.00
2	150,000.00	20,000.00
3	200,000.00	45,000.00
4	250,000.00	75,000.00
5	300,000.00	109,000.00
6	350,000.00	147,000.00
7	400,000.00	188,000.00
8	450,000.00	232,000.00
9	500,000.00	278,000.00

	90 1000 acre-ft	**70 1000 acre-ft**
6: RioLosPinosAtOrtiz	34.00	42.00
7: Lobatos	34.00	5.00
8: LobatosAnnual	NaN	173.00

- Therefore, URGWOM forecasts that Colorado will EXACTLY meet its annual Lobatos delivery requirement

April – July Lobatos forecast computation

- In 2021, the 70% April to July Lobatos forecast is:
  - The 173 KAF annual forecast
  - Minus the Jan 1 – March 31 *gaged* flow at Del Norte + Mogote + R. Los Pinos + R. San Antonio (118 KAF)
  - Minus the August 1 – December 31 *forecasted* flow at Del Norte + Mogote + R. Los Pinos + R. San Antonio (68 KAF)
  - 173 – 118 – 68 = -13 KAF.
- Since we can't have a negative forecast, URGWOM rounds up to 5 KAF:



5 KAF is not a realistic Lobatos spring runoff.

Hydros Consulting

Before:

84 Estimate Lobatos Apr-Jul Forecasted Volume

Set Value Flag: Rules (R)

```
WITH ( STRING NRCSForecast
       = GetWholeNumberAsString ( GetNRCSForecast ( ) ) ) DO
  WITH ( STRING month
         = GetMonthAsString ( GetStartDate ( ) ) ) DO
    InputForecastData . ( "Forecasts" CONCAT month ) [ "Lobatos" ,
                                                       NRCSForecast ]
      = IF ( GetStartDate ( ) <= NextDate ( CompletePartialDate ( @"January" ,
                                                                  GetStartDate ( ) ) ,
                                            NumberToDate ( InputForecastData.ForecastPeriods [ "Lobatos" ,
                                                                                               "End Date" ] ) ) ) THEN
        Max ( RoundVolumeToFactor ( ( # RioGrandeIndexCalculation
                                      RioGrandeIndexFlowVolume ( )
                                      - ( RioGrandeIndexFlowVolumeForLobatosJan-Mar ( )
                                        + RioGrandeIndexFlowVolumeForLobatosOct-Dec ( ) )
                                      + ( # ConejosIndexCalculation
                                          ConejosIndexFlowVolume ( )
                                          - ( ConejosIndexFlowVolumeForLobatosJan-Mar ( )
                                            + ConejosIndexFlowVolumeForLobatosOct-Dec ( ) ) )
                                    * # Assume 70% of April-October Lobatos flow volume occurs April-July.
                                      0.70000000 ,
                                    100.00000000 "acre-ft" ) ,
            5,000.00000000 "acre-ft" )
      ELSE
```

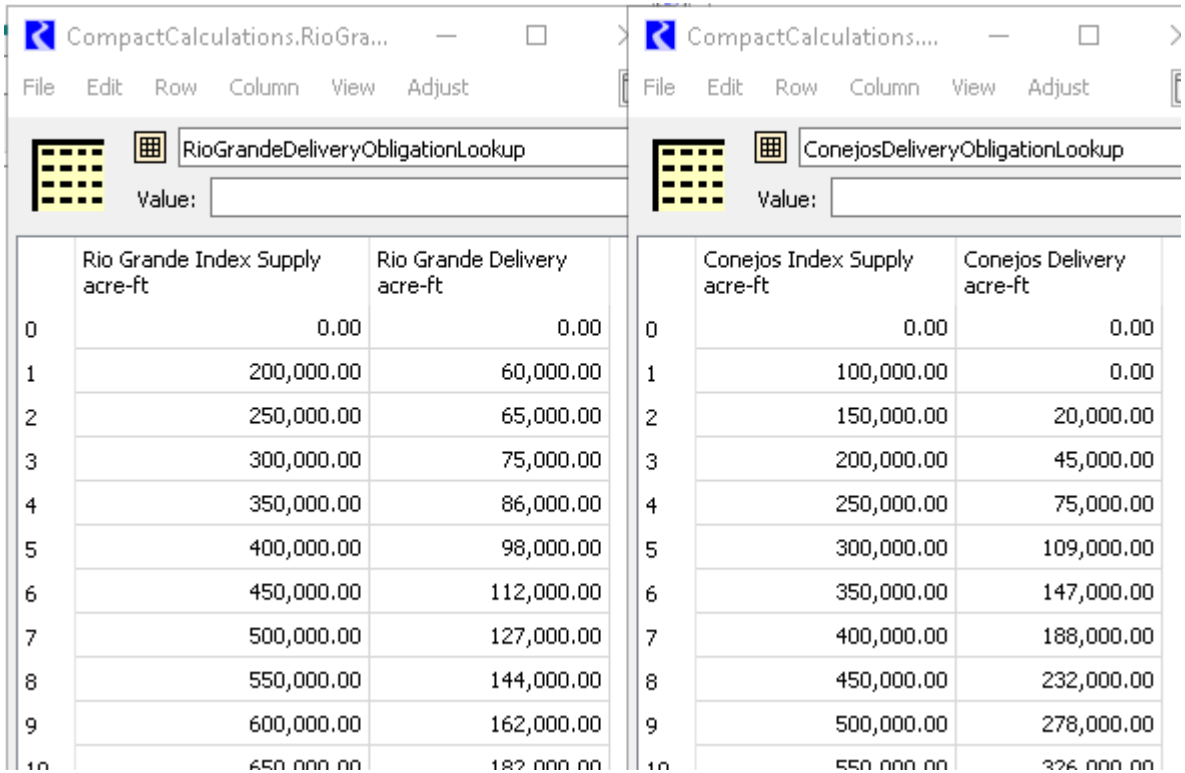
ForecastsApril

Value: 5

	70 1000 acre-ft
6: RioLosPinosAtOrtiz	42.00
7: Lobatos	5.00
8: LobatosAnnual	173.00

Proposed Fix

- Proposed fix: For the Lobatos forecast, URGWOM needs to convert the Jan 1 – March 31, and August 1 through Dec 31 *index supply flows* to *delivery flows*, using the compact tables



	Rio Grande Index Supply acre-ft	Rio Grande Delivery acre-ft
0	0.00	0.00
1	200,000.00	60,000.00
2	250,000.00	65,000.00
3	300,000.00	75,000.00
4	350,000.00	86,000.00
5	400,000.00	98,000.00
6	450,000.00	112,000.00
7	500,000.00	127,000.00
8	550,000.00	144,000.00
9	600,000.00	162,000.00
10	650,000.00	182,000.00

	Conejos Index Supply acre-ft	Conejos Delivery acre-ft
0	0.00	0.00
1	100,000.00	0.00
2	150,000.00	20,000.00
3	200,000.00	45,000.00
4	250,000.00	75,000.00
5	300,000.00	109,000.00
6	350,000.00	147,000.00
7	400,000.00	188,000.00
8	450,000.00	232,000.00
9	500,000.00	278,000.00
10	550,000.00	326,000.00

Proposed Changes

Hydros Consulting

After:

84 Estimate Lobatos Apr-Jul Forecasted Volume

Set Value Flag: Rules (R)

```
WITH ( STRING NRCSForecast
       = GetWholeNumberAsString ( GetNRCSForecast ( ) ) ) DO
  WITH ( STRING month
         = GetMonthAsString ( GetStartDate ( ) ) ) DO
    InputForecastData . ( "Forecasts" CONCAT month ) [ "Lobatos" ,
                                                       NRCSForecast ]
      = IF ( GetStartDate ( ) <= NextDate ( CompletePartialDate ( @"January" ,
                                                                   GetStartDate ( ) ) ,
                                            NumberToDate ( InputForecastData.ForecastPeriods [ "Lobatos" ,
                                                                                               "End Date" ] ) ) ) THEN
        Max ( RoundVolumeToFactor ( # RioGrandeIndexCalculation
                                    TableInterpolation ( CompactCalculations.RioGrandeDeliveryObligationLookup ,
                                                         0.00000000 ,
                                                         1.00000000 ,
                                                         RioGrandeIndexSupplyVolume ( )
                                                         - ( RioGrandeIndexFlowVolumeForLobatosJan-Mar ( )
                                                           + RioGrandeIndexFlowVolumeForLobatosOct-Dec ( ) ) ,
                                                         @"t" )
                                  + # ConejosIndexCalculation
                                    TableInterpolation ( CompactCalculations.ConejosDeliveryObligationLookup ,
                                                         0.00000000 ,
                                                         1.00000000 ,
                                                         ConejosIndexSupplyVolume ( )
                                                         - ( ConejosIndexFlowVolumeForLobatosJan-Mar ( )
                                                           + ConejosIndexFlowVolumeForLobatosOct-Dec ( ) ) ,
                                                         @"t" )
                                  * # Assume 70% of April-October Lobatos flow volume occurs April-July.
                                    0.70000000 ,
                                  100.00000000 "acre-ft" ) ,
                  5,000.00000000 "acre-ft" )
```

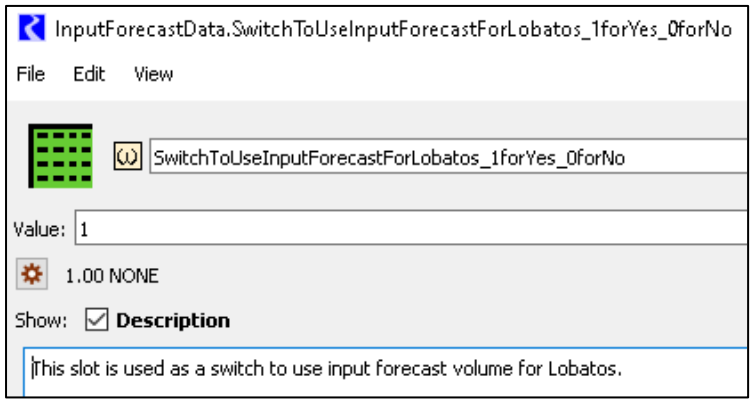
ForecastsApril

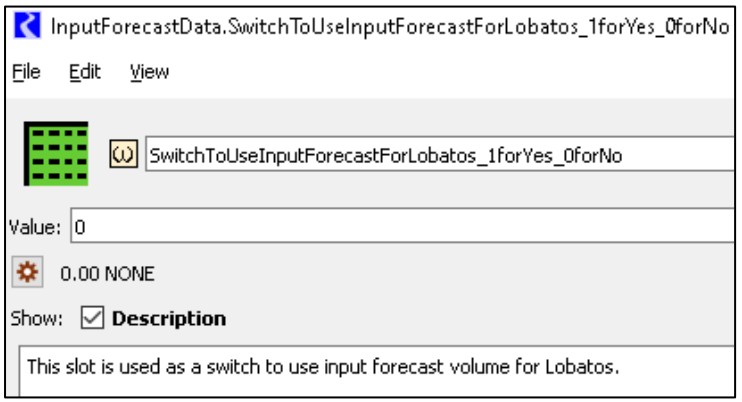
Value: 75.8 1000 acre

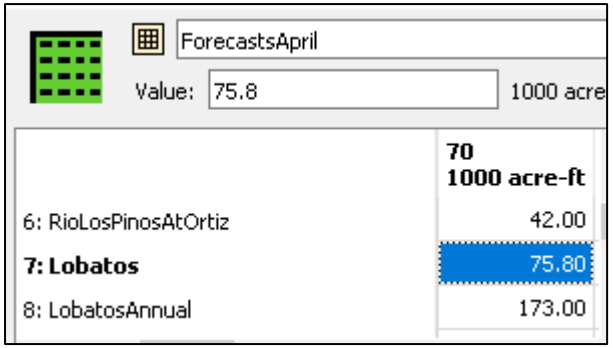
	70 1000 acre-ft
6: RioLosPinosAtOrtiz	42.00
7: Lobatos	75.80
8: LobatosAnnual	173.00

AOP run with Colorado Enabled

- We need to fix the Lobatos forecast in case it is ever used
- However, whether it's computed or not, the Lobatos forecast isn't currently used (when Colorado is enabled):



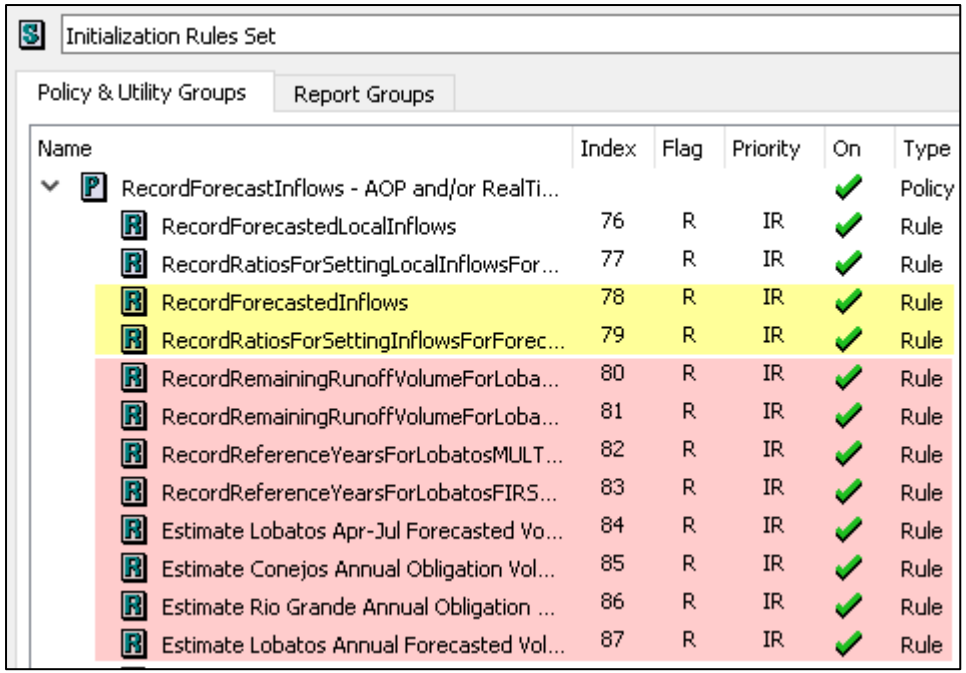




No effect on model results

AOP run with Colorado Enabled

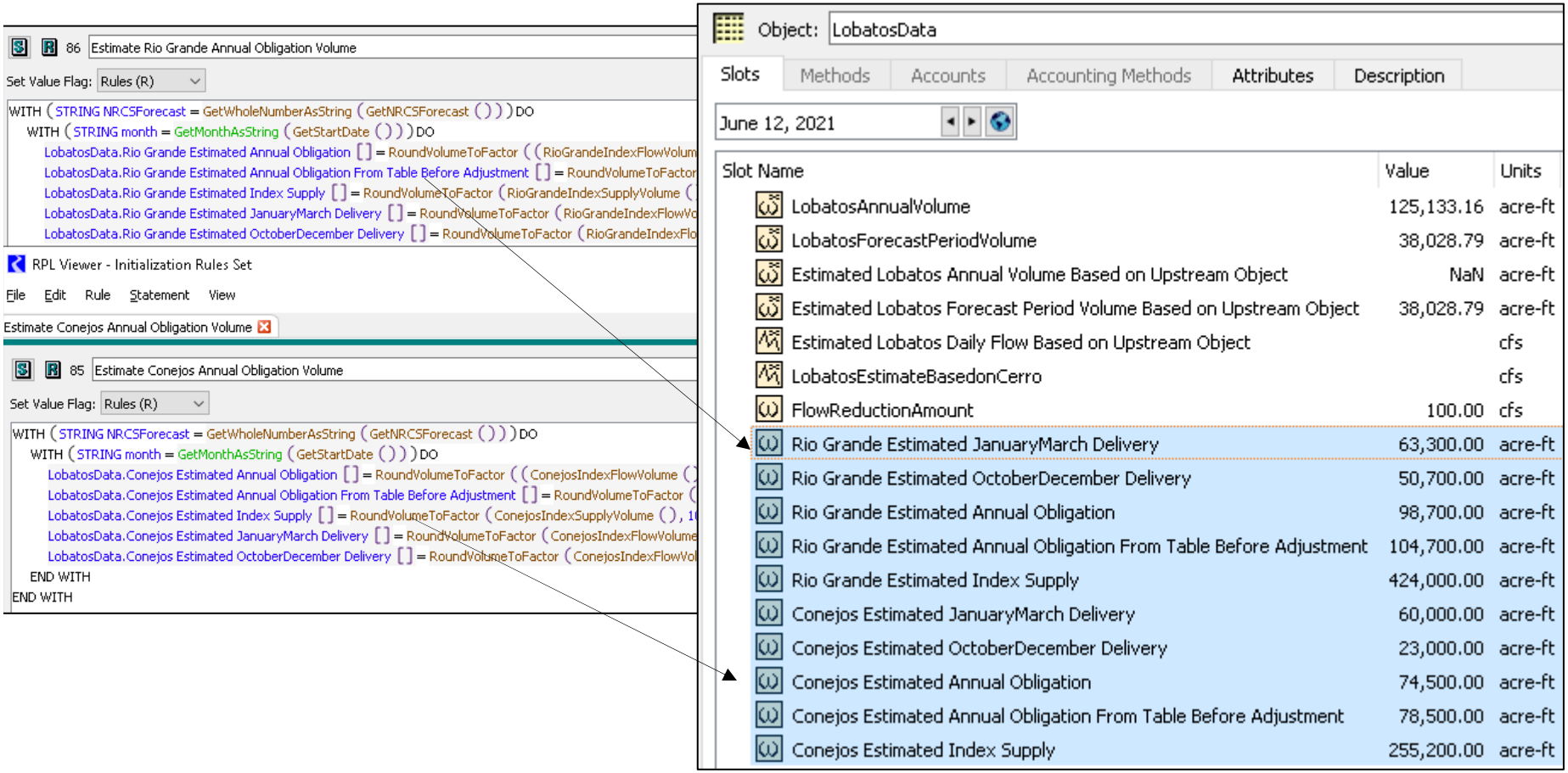
- The red-highlighted initialization rules could be disabled in all model configurations, and the yellow-highlighted rules could be trimmed down.
- However, the Lobatos forecast is a good reference



Name	Index	Flag	Priority	On	Type
RecordForecastInflows - AOP and/or RealTi...				✓	Policy
RecordForecastedLocalInflows	76	R	IR	✓	Rule
RecordRatiosForSettingLocalInflowsFor...	77	R	IR	✓	Rule
RecordForecastedInflows	78	R	IR	✓	Rule
RecordRatiosForSettingInflowsForForec...	79	R	IR	✓	Rule
RecordRemainingRunoffVolumeForLoba...	80	R	IR	✓	Rule
RecordRemainingRunoffVolumeForLoba...	81	R	IR	✓	Rule
RecordReferenceYearsForLobatosMULT...	82	R	IR	✓	Rule
RecordReferenceYearsForLobatosFIRS...	83	R	IR	✓	Rule
Estimate Lobatos Apr-Jul Forecasted Vo...	84	R	IR	✓	Rule
Estimate Conejos Annual Obligation Vol...	85	R	IR	✓	Rule
Estimate Rio Grande Annual Obligation ...	86	R	IR	✓	Rule
Estimate Lobatos Annual Forecasted Vol...	87	R	IR	✓	Rule

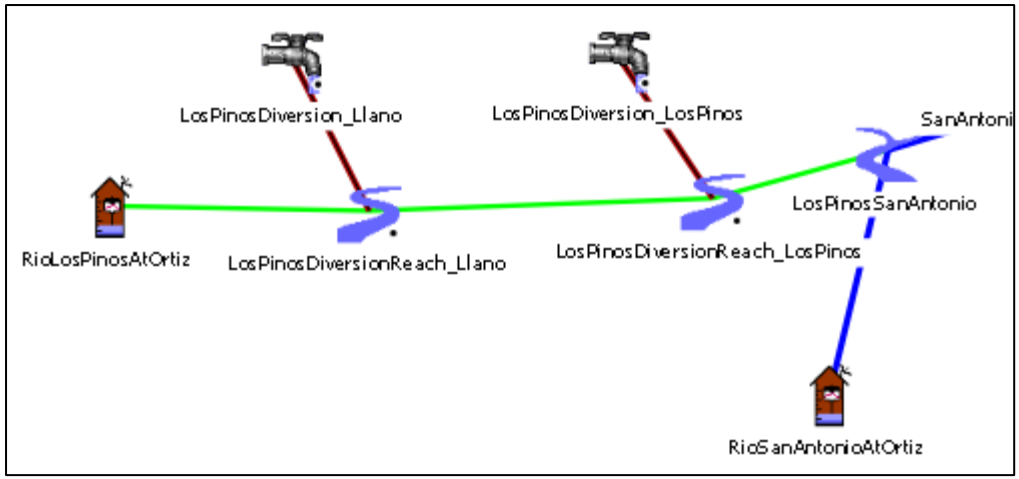
AOP run with Colorado Enabled

- Particularly: Initialization Rules 86 & 85 write to a slot that isn't used by any rules or DMIs, so these rules and slots might be considered for deletion:



AOP run with Colorado Enabled

- So if Lobatos hydrograph has nothing to do with Lobatos forecast, how is hydrograph at Lobatos computed in an AOP run?
- The Lobatos hydrograph is based on:
  1. Forecasted inflows above Lobatos
  2. Compact Tables



CompactCalculations.RioGra...

File Edit Row Column View Adjust

RioGrandeDeliveryObligationLookup

Value:

	Rio Grande Index Supply acre-ft	Rio Grande Delivery acre-ft
0	0.00	0.00
1	200,000.00	60,000.00
2	250,000.00	65,000.00
3	300,000.00	75,000.00
4	350,000.00	86,000.00
5	400,000.00	98,000.00
6	450,000.00	112,000.00
7	500,000.00	127,000.00
8	550,000.00	144,000.00
9	600,000.00	162,000.00

CompactCalculations....

File Edit Row Column View Adjust

ConejosDeliveryObligationLookup

Value:

	Conejos Index Supply acre-ft	Conejos Delivery acre-ft
0	0.00	0.00
1	100,000.00	0.00
2	150,000.00	20,000.00
3	200,000.00	45,000.00
4	250,000.00	75,000.00
5	300,000.00	109,000.00
6	350,000.00	147,000.00
7	400,000.00	188,000.00
8	450,000.00	232,000.00
9	500,000.00	278,000.00

1) Forecasted Inflows and Local Inflows in CO

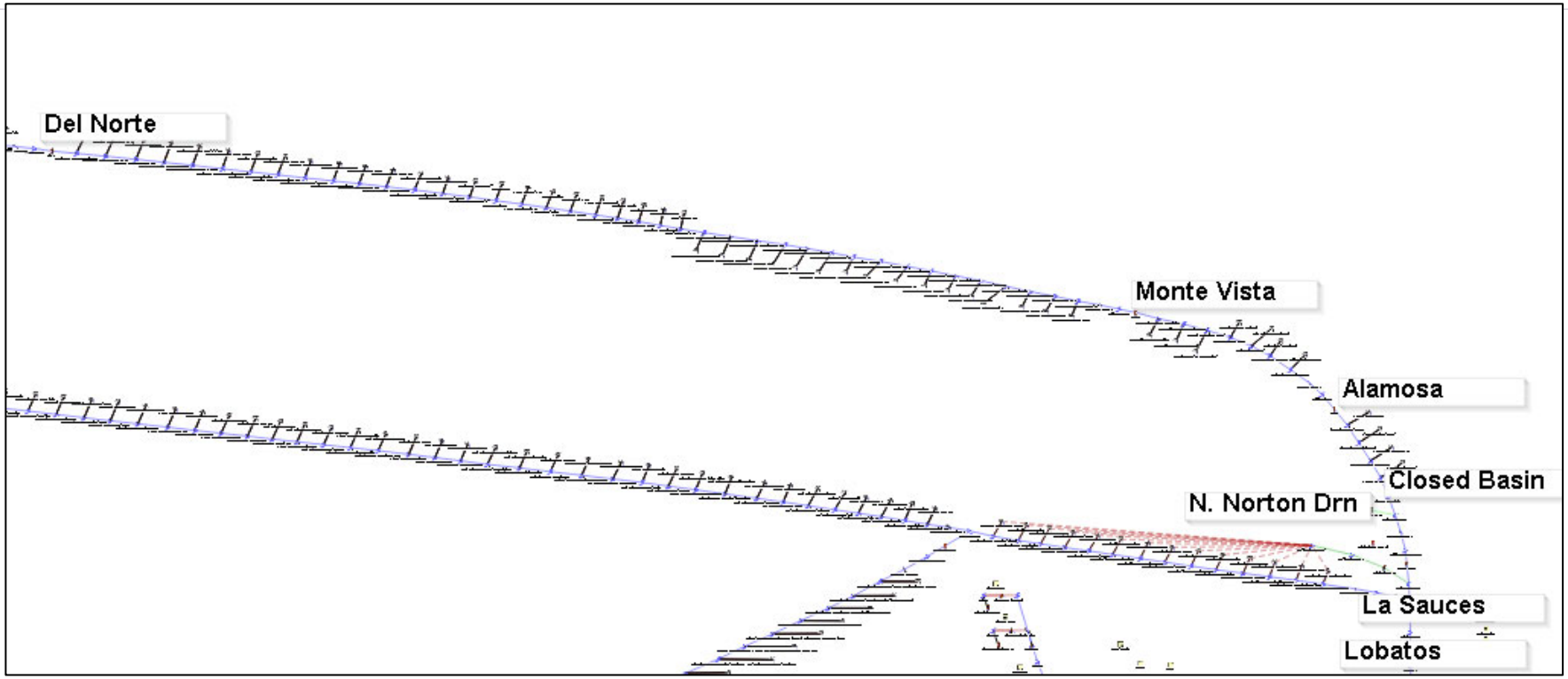
- In AOP runs, many local inflow locations in Colorado use the Forecast year from a different location. For instance:

ReferenceYearForOtherURGWOMInputLocationsMappedToForecastLocation

Value:

	1=Lobatos, 2=LobatosAnnual, 3=RedRiverBlwFishHatchery, 4=RioPuebloDeTaosAtLosCordovas, 5=Otowi, 6=NrJemez, 7=ElVadoInflow, 8=RioBlanco, 9=NavajoRiver, 10=DelNorte, 11=ThirtyMileBridge, 12=WagonWheelGap, 13=Mogote, 14=RioSanAntonioAtOrtiz
0: NorthClearCreekBelowContinentalReservoir	11.00
1: ClosedBasinProjectCanal	10.00
2: NorthChannelNortonDrain	10.00
3: LocalInflowsAtWagonWheelGap	12.00
4: LocalInflowsAtDelNorte	10.00
5: LocalInflowsAtMonteVista	10.00
6: LocalInflowsAtAlamosa	10.00
7: LocalInflowsToRioGrandeAtLaSauces	10.00
8: LocalInflowsAtMogote	13.00
9: LocalInflowsToSanAntonioRiverAtManassa	14.00
10: LocalInflowsToConejosAtLaSauces	10.00
11: LocalInflowsAtLobatos	10.00
12: LittleNavajoRiver	9.00
13: Galisteo	5.00
14: NorthFloodwayChannel	5.00
15: SouthDiversionChannel	5.00
16: RioPuerco	5.00

Local Inflows between Del Norte and Lobatos use the Del Norte forecast year



- Even though these Local Inflows are downstream (up to 90 river miles) of Del Norte, they use the Del Norte forecast
  - because there is no other option: can't use Lobatos (no NRCS forecast) or Otowi (affected by Rio Chama)

Local Inflows between Del Norte and Lobatos use the Del Norte forecast year

- If the Del Norte forecast is high, this means the Local Inflows between Del Norte and Lobatos will also be high, which means the flow at Lobatos will be high.
- In 2021, Del Norte was flow was forecasted to be 71-78% of average:

	2021 Del Norte forecasts	
	50% (KAF)	% of average
January	400	78%
February	400	78%
March	365	71%
April	365	71%

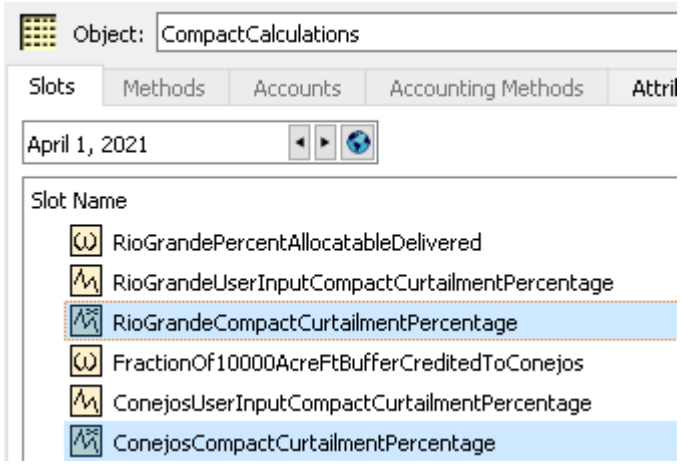
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/waterproducts/basin

- However, NRCS predicted that Lobatos flow would be approximately 40% of average*

**https://www.nrcs.usda.gov/wps/portal/nrcs/main/nm/snow/waterproducts/basin/*

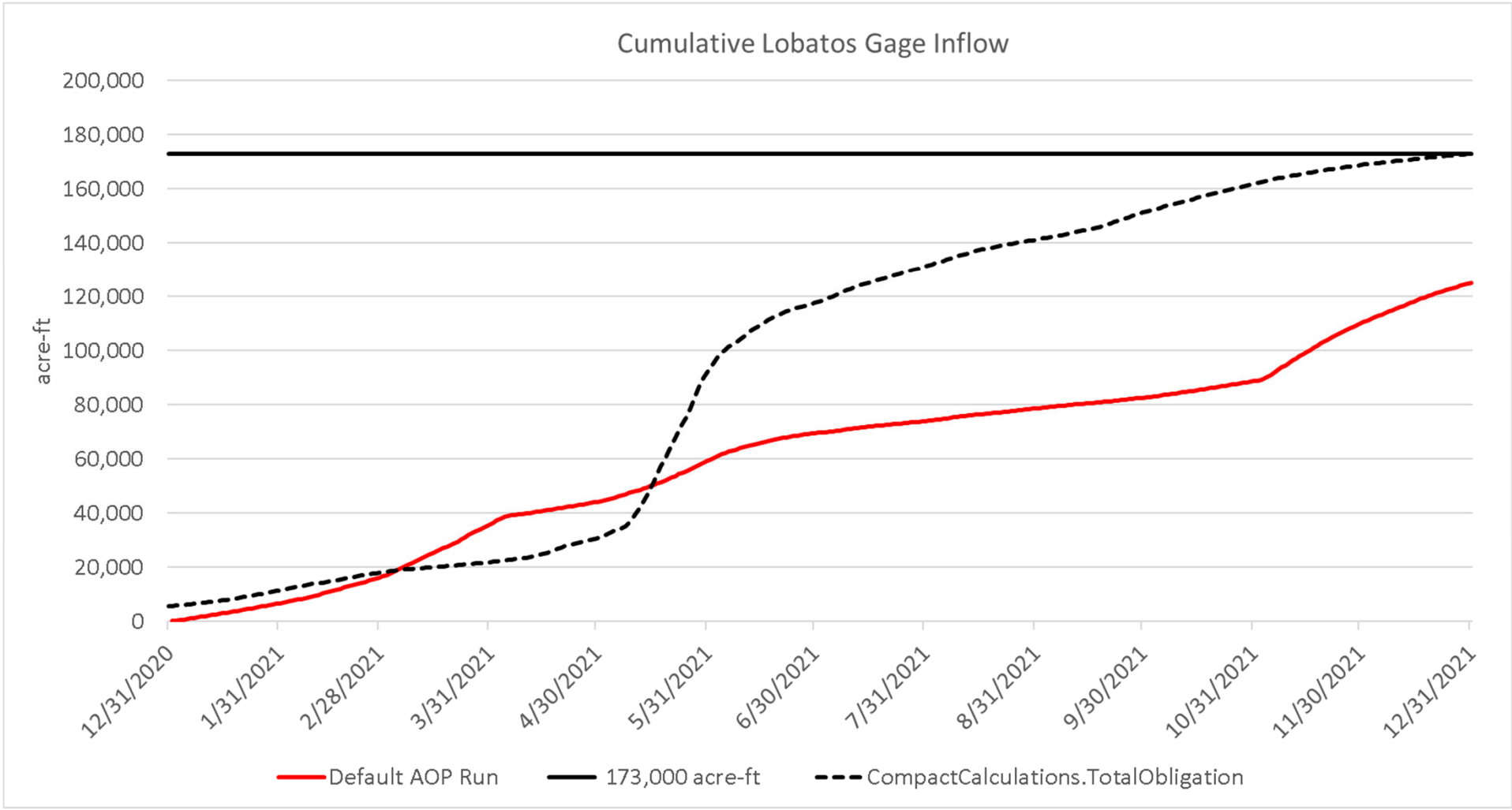
3) Agricultural diversions in Colorado

- The CO agricultural curtailment percentage mentioned earlier ensures that Colorado exactly meets annual Lobatos delivery obligation



- However, in recent AOP runs, annual delivery obligation not being met, even while CO ditches diverting

3) Agricultural diversions in Colorado



3) Agricultural diversions in Colorado

- Propose the following changes:

BEFORE

RioGrandeProjectedObligationForYear

Value: 82228.1576810128

Evaluation Time: End of timestep, current timestep only

Evaluation Range: Run start to run finish (Step: 1 DAY)

```
IF ( IsFirstTimestepOfYear ( ) OR IsNaN CompactCalculations.RioGrandeProjectedObligationForYear [ @"t - 1" ] ) THEN
    ( TableInterpolation ( CompactCalculations.RioGrandeDeliveryObligationLookup ,
                           0.00000000 ,
                           1.00000000 ,
                           CompactCalculations.RioGrandeProjectedNaturalizedDelNorteFlowForYear [ ] ,
                           @"t" )
    - ( 1.00000000
      - CompactCalculations.FractionOf10000AcreFtBufferCreditedToConejos [ ] )
      * 10,000.00000000 "acre-ft" )
    * CompactCalculations.RioGrandeProjectedObligationCorrection [ "DelNorte" ,
                                                                   "slope" ]
    + CompactCalculations.RioGrandeProjectedObligationCorrection [ "DelNorte" ,
                                                                   "intercept" ]
ELSE
    CompactCalculations.RioGrandeProjectedObligationForYear [ @"t - 1" ]
END IF
```

AFTER

RioGrandeProjectedObligationForYear

Value: acre-

Evaluation Time: End of timestep, current timestep only

Evaluation Range: Run start to run finish (Step: 1 DAY)

```
IF ( IsFirstTimestepOfYear ( )
   OR IsNaN CompactCalculations.RioGrandeProjectedObligationForYear [ @"t - 1" ] ) THE
    RioGrandeIndexFlowVolume ( )
    - ( 1.00000000
      - CompactCalculations.FractionOf10000AcreFtBufferCreditedToConejos [ ] )
      * 10,000.00000000 "acre-ft"
ELSE
    CompactCalculations.RioGrandeProjectedObligationForYear [ @"t - 1" ]
END IF
```

3) Agricultural diversions in Colorado

- Propose the following changes:

BEFORE

ConejosProjectedObligationForYear

Value: 43089.8437225401

Evaluation Time: End of timestep, current timestep only

Evaluation Range: Run start to run finish (Step: 1 DAY)

```
IF ( IsFirstTimestepOfYear ( ) OR IsNaN CompactCalculations.ConejosProjectedObligationForYear [ @"t - 1" ] ) THEN
   TableInterpolation ( CompactCalculations.ConejosDeliveryObligationLookup ,
                        0.00000000 ,
                        1.00000000 ,
                        SumFlowsToVolumeSkipNaN ( PlatoroInflow.Inflow ,
                                                  FirstTimestepOfYear ( ),
                                                  @"24:00:00 December 31, Current Year" )
                        * ( # Platoro to Mogote losses are constant in time and by flow, so table look up indices don't matter
                            1.00000000
                            + PlatoroToMogoteLossesAndLag:Losses.Variable GainLoss Coeff Table [ "Season 9" ,
                                                                                                 "Flow Range 1" ] )
                        + SumFlowsToVolumeSkipNaN ( LocalInflowsAtMogote.Local Inflow ,
                                                    @"t" ,
                                                    @"24:00:00 December 31, Current Year" )
                        + SumFlowsToVolumeSkipNaN ( RioLosPinosAtOrtiz.Gage Inflow ,
                                                    RoundDateToTimestepEnd ( @"24:00:00 April 1, Current Year" ),
                                                    @"24:00:00 October 31, Current Year" )
                        + SumFlowsToVolumeSkipNaN ( RioSanAntonioAtOrtiz.Gage Inflow ,
                                                    RoundDateToTimestepEnd ( @"24:00:00 April 1, Current Year" ),
                                                    @"24:00:00 October 31, Current Year" ),
                        @"t" )
   - CompactCalculations.FractionOf10000AcreFtBufferCreditedToConejos [ ]
     * 10,000.00000000 "acre-ft"
ELSE
   CompactCalculations.ConejosProjectedObligationForYear [ @"t - 1" ]
END IF
```

AFTER

ConejosProjectedObligationForYear

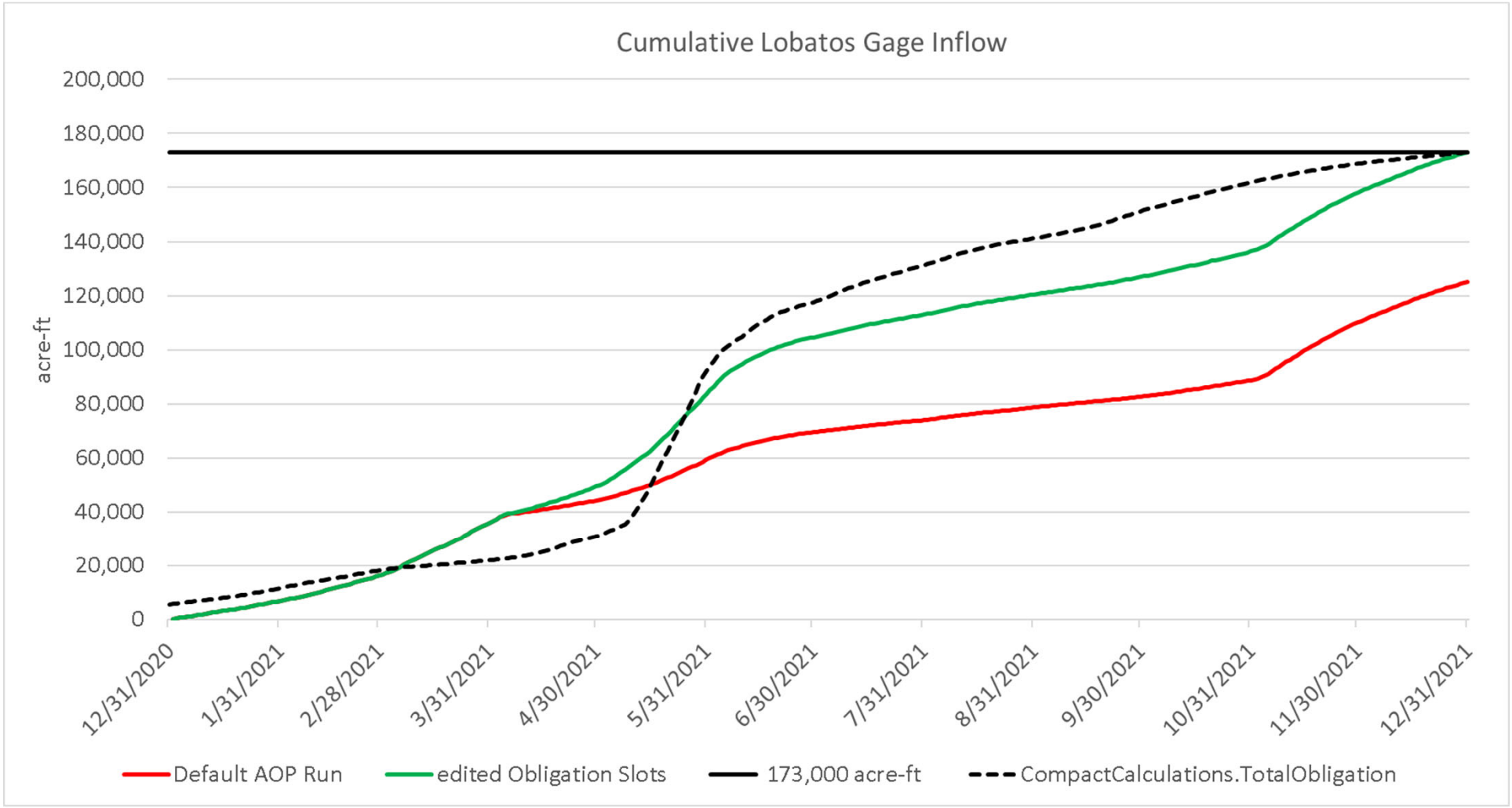
Value: acre

uation Time: End of timestep, current timestep only

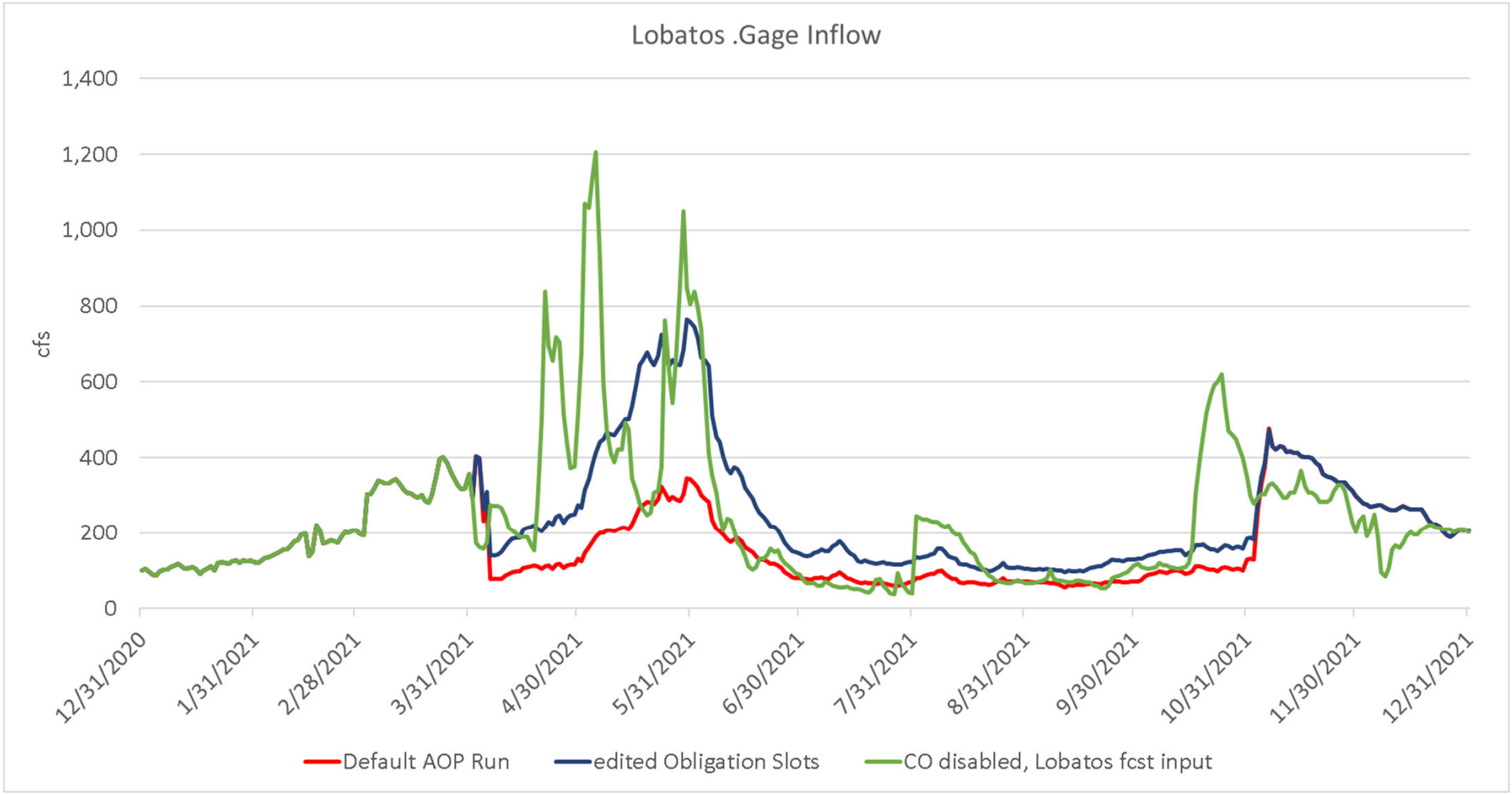
uation Range: Run start to run finish (Step: 1 DAY)

```
IF ( IsFirstTimestepOfYear ( )
   OR IsNaN CompactCalculations.ConejosProjectedObligationForYear [ @"t - 1" ] )
   ConejosIndexFlowVolume ( )
   - CompactCalculations.FractionOf10000AcreFtBufferCreditedToConejos [ ]
     * 10,000.00000000 "acre-ft"
ELSE
   CompactCalculations.ConejosProjectedObligationForYear [ @"t - 1" ]
END IF
```

3) Agricultural diversions in Colorado



3) Agricultural diversions in Colorado

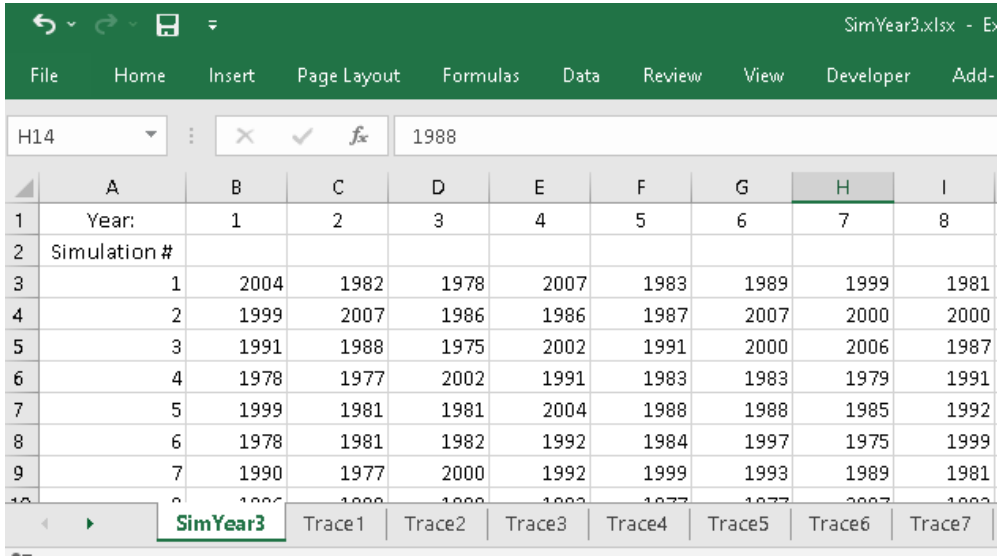


AOP Run Conclusion

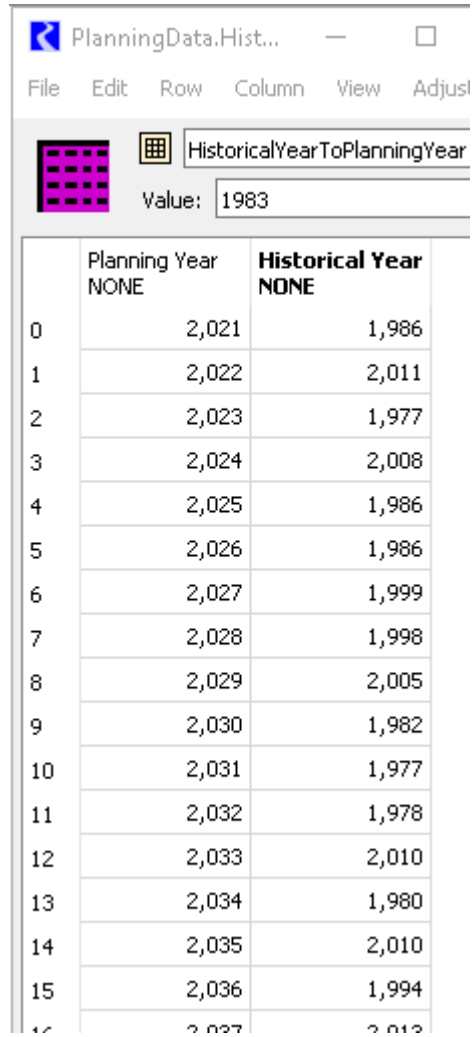
- Once all of these proposed changes are made, the Annual Compact Obligation will arrive at Lobatos, as Marc had mentioned.
- URGWOM seems to model everything as accurately as possible, given data availability
- However, the model user may choose to manually input their own inflow hydrographs, for many reasons, e.g.,
  1) They don't agree with the timing of the URGWOM-computed hydrograph, since the pattern is based on a historical year
  2) They don't agree with URGWOM's assumptions that CO will meet the compact requirement. They may want smaller Inflows.
  3) They many not agree with URGWOM's assumptions that many of the Colorado local inflows are based on the upstream Del Norte forecast
  4) They many not agree with URGWOM's assumption that all CO diverters try to divert 100% of their water right from April 1 – Oct 31 (except when curtailed by compact restrictions)

Planning Run

- Marc was also interested in how the Lobatos hydrograph is computed in Planning Runs
- Same as the two types of AOP runs, except that instead of using Forecast years, CO inflows are based on a user-input table:
- These year-sequences can be randomly generated, and 1000s of long-term planning runs can be run to evaluate a variety of possible futures.



	A	B	C	D	E	F	G	H	I
1	Year:	1	2	3	4	5	6	7	8
2	Simulation #								
3	1	2004	1982	1978	2007	1983	1989	1999	1981
4	2	1999	2007	1986	1986	1987	2007	2000	2000
5	3	1991	1988	1975	2002	1991	2000	2006	1987
6	4	1978	1977	2002	1991	1983	1983	1979	1991
7	5	1999	1981	1981	2004	1988	1988	1985	1992
8	6	1978	1981	1982	1992	1984	1997	1975	1999
9	7	1990	1977	2000	1992	1999	1993	1989	1981



	Planning Year NONE	Historical Year NONE
0	2,021	1,986
1	2,022	2,011
2	2,023	1,977
3	2,024	2,008
4	2,025	1,986
5	2,026	1,986
6	2,027	1,999
7	2,028	1,998
8	2,029	2,005
9	2,030	1,982
10	2,031	1,977
11	2,032	1,978
12	2,033	2,010
13	2,034	1,980
14	2,035	2,010
15	2,036	1,994

Questions?

Hydros Consulting