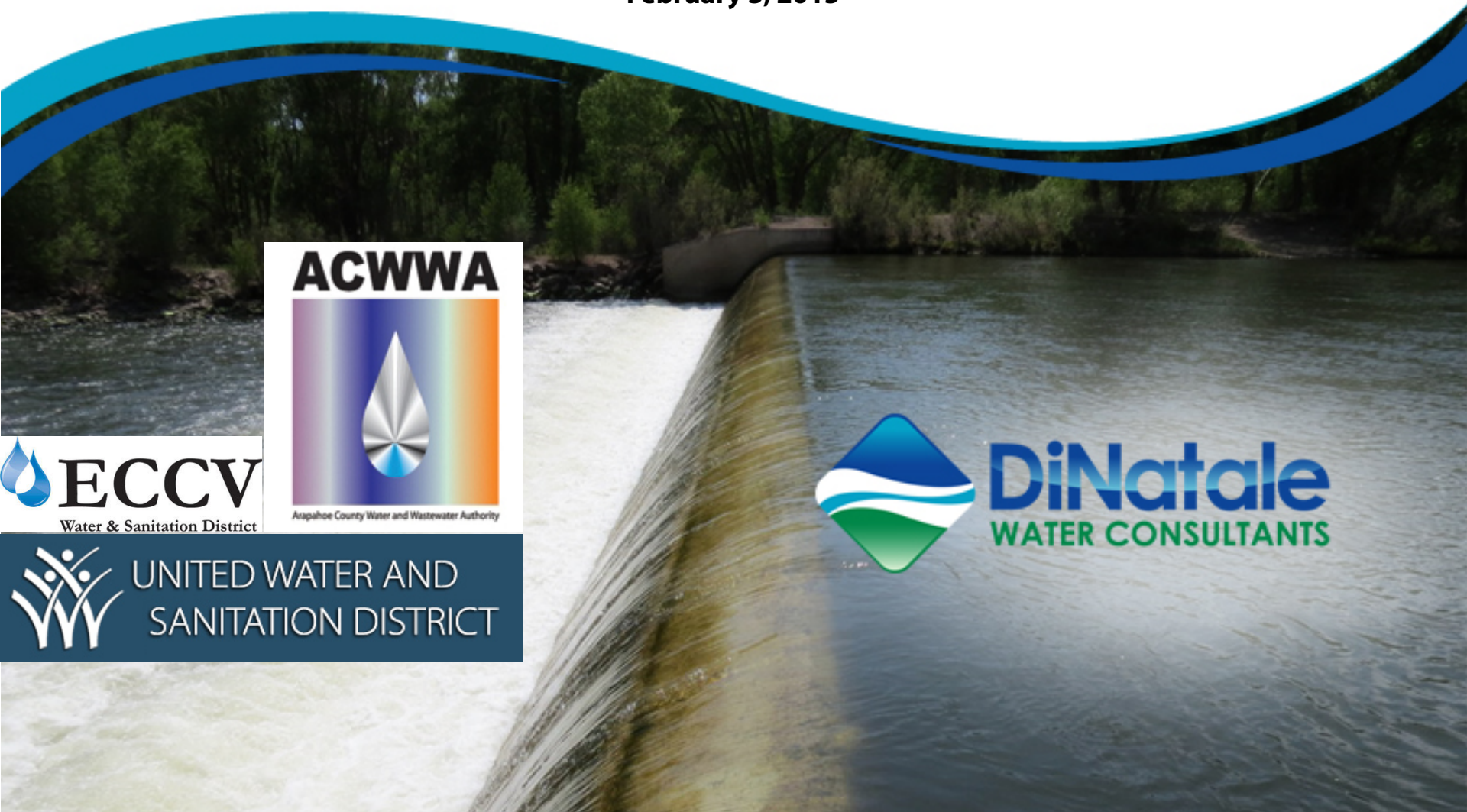
South Platte River - Northern Project Renewable Water Supply

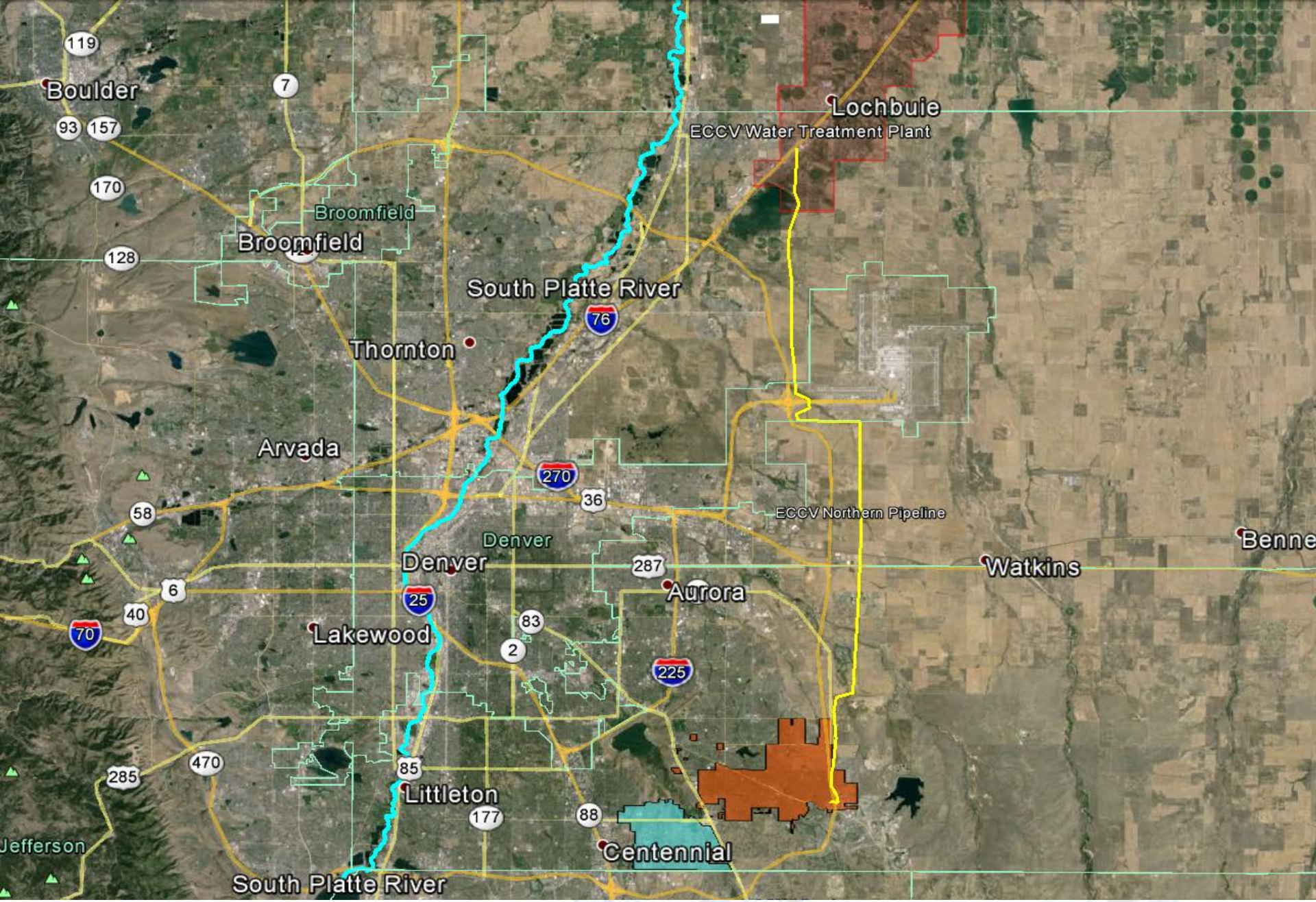
Planning and Operations Model Update

February 3, 2015



Northern Project Renewable Water Supply

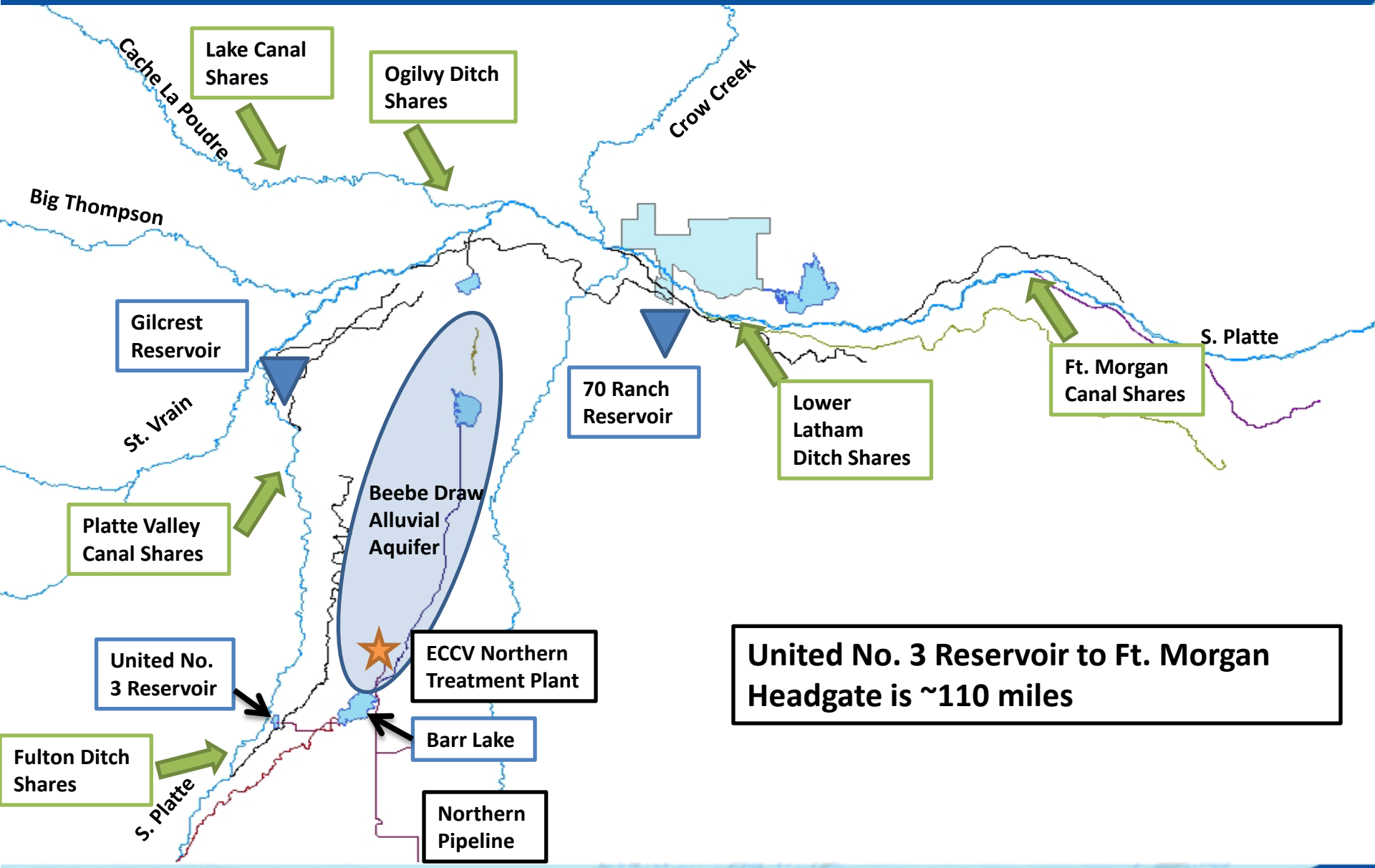
- Renewable water supply for portions of Arapahoe, Douglas, and Elbert Counties (Denver SE Metro area)
- Supply currently met largely with deep non-tributary wells in the Denver/Dawson, Arapahoe, and Laramie-Fox Hills Aquifers
- ACWWA demand expected to double by 2040 and ECCV demand expected to increase by 15% by 2022
- New renewable supply (S. Platte Basin) obtained from:
  - Senior mutual ditch company rights
  - Junior water rights
  - Recharge and augmentation of alluvial wells


Boulder
Broomfield
Broomfield
Lochbuie
ECCV Water Treatment Plant
South Platte River
Thornton
Arvada
Denver
Denver
Aurora
Watkins
ECCV Northern Pipeline
Lakewood
Littleton
Centennial
South Platte River
Jefferson
119
7
93
157
170
128
76
270
36
58
6
40
70
25
83
2
287
225
285
470
85
177
88

Northern Project Modeling

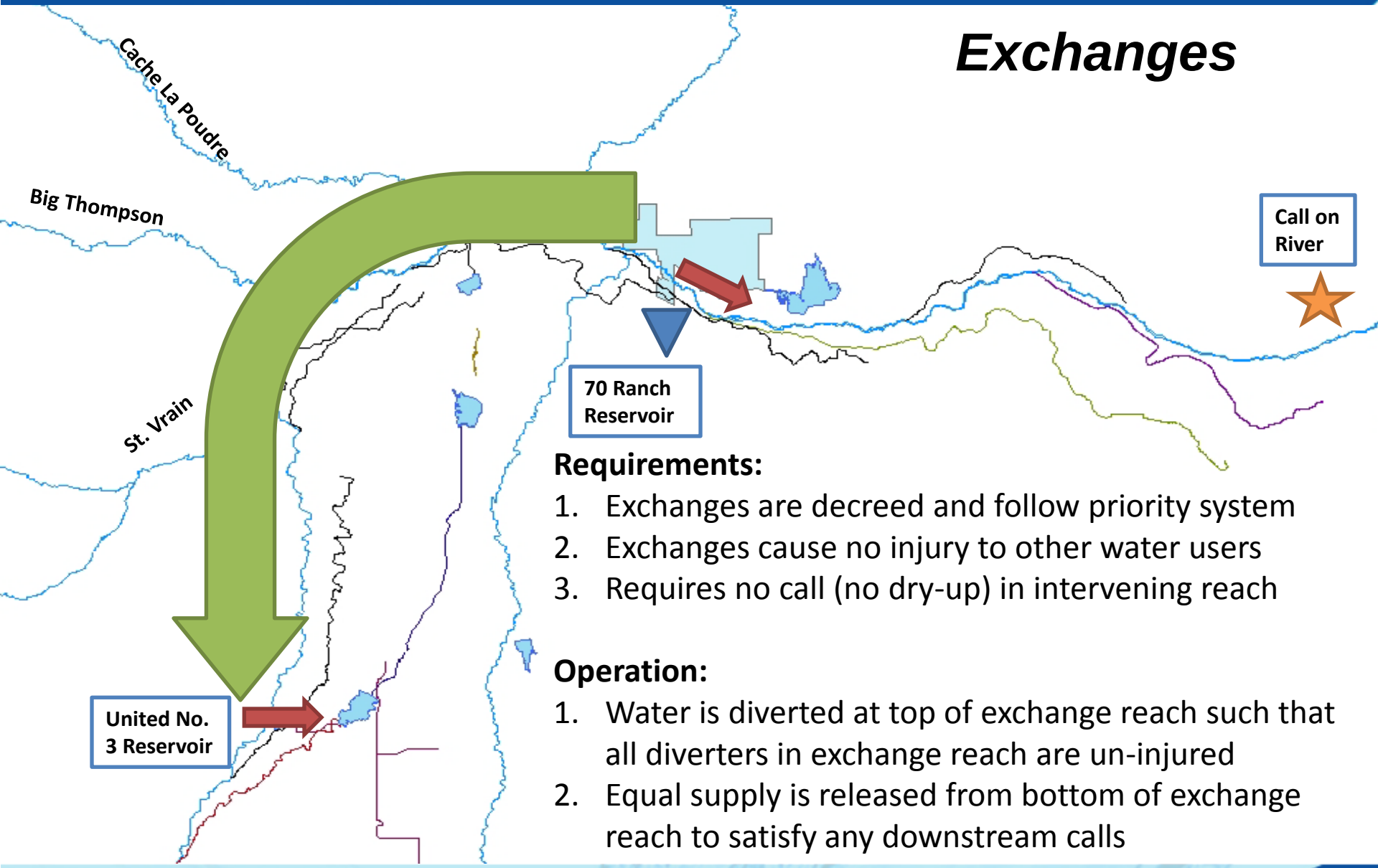
- Only modeling our operations
- Approximately $40 million to be committed this year based on results of model
- Sizing of infrastructure
  - Recharge facilities
  - Pipeline sizing
  - Reservoir location and sizing
- Evaluation of water rights
- Evaluation of possible water court decisions
- Groundwater accounting tool

Sources of Supply and System Demands



United No. 3 Reservoir to Ft. Morgan Headgate is ~110 miles

Movement of Supply UP South Platte River



Exchanges

Requirements:

1. Exchanges are decreed and follow priority system
2. Exchanges cause no injury to other water users
3. Requires no call (no dry-up) in intervening reach

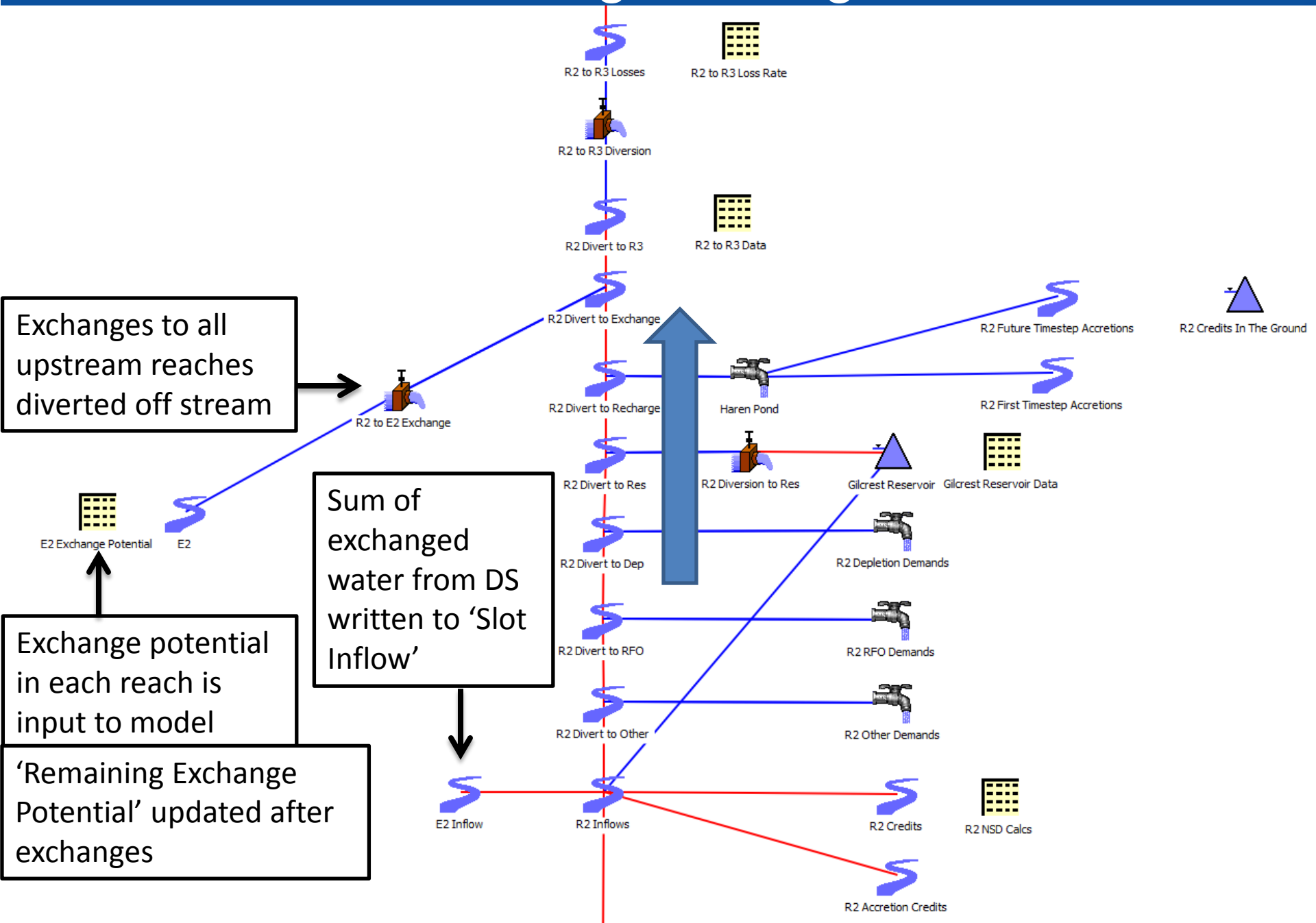
Operation:

1. Water is diverted at top of exchange reach such that all diverters in exchange reach are un-injured
2. Equal supply is released from bottom of exchange reach to satisfy any downstream calls

Ideas to Model Exchanges

- Run the river backwards
  - Confusing
  - Credits and reservoir releases propagate downstream
- Parallel reaches running upstream and downstream
  - Difficult to control diversion and propagation between reaches
  - Exchange potential varies between reaches
  - Outflows don't solve until upstream diversions solve – chicken or egg problem
- Pipeline Object
  - Requires 1 object for every combination of reach to reach
- Diversion from reaches and rule-based Slot Inflow

Modeling Exchanges

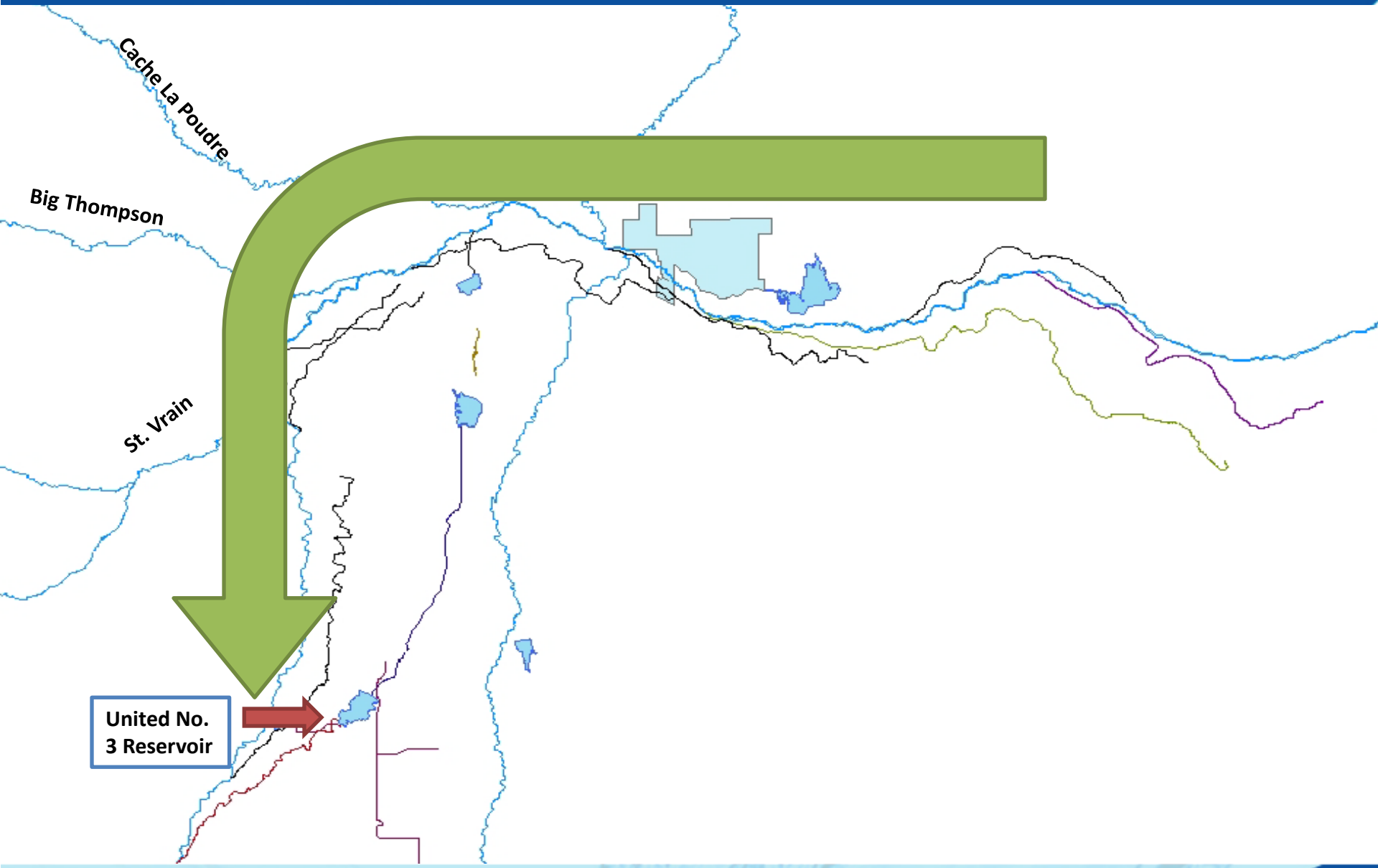


Exchanges to all upstream reaches diverted off stream

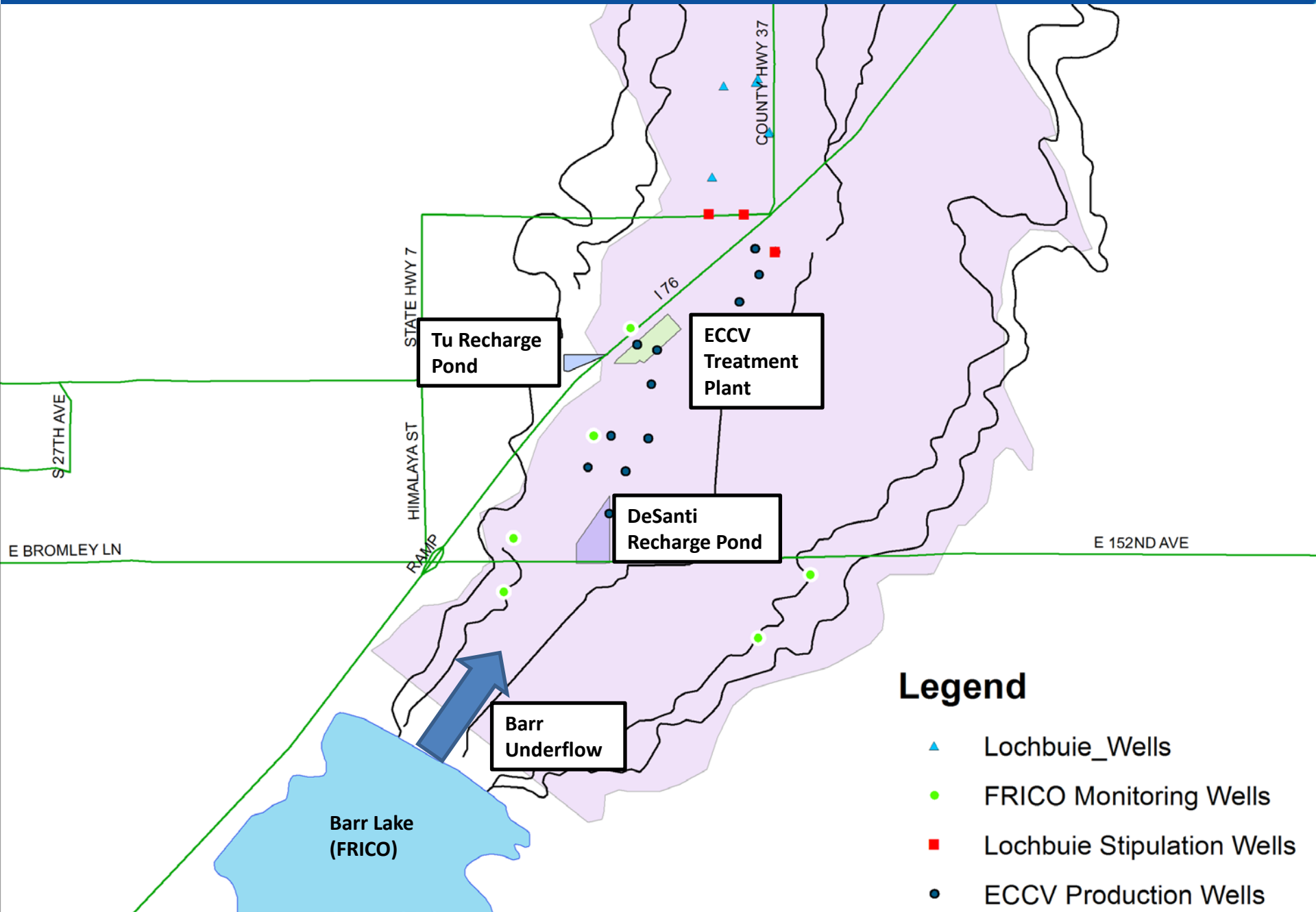
Exchange potential in each reach is input to model

Sum of exchanged water from DS written to 'Slot Inflow'

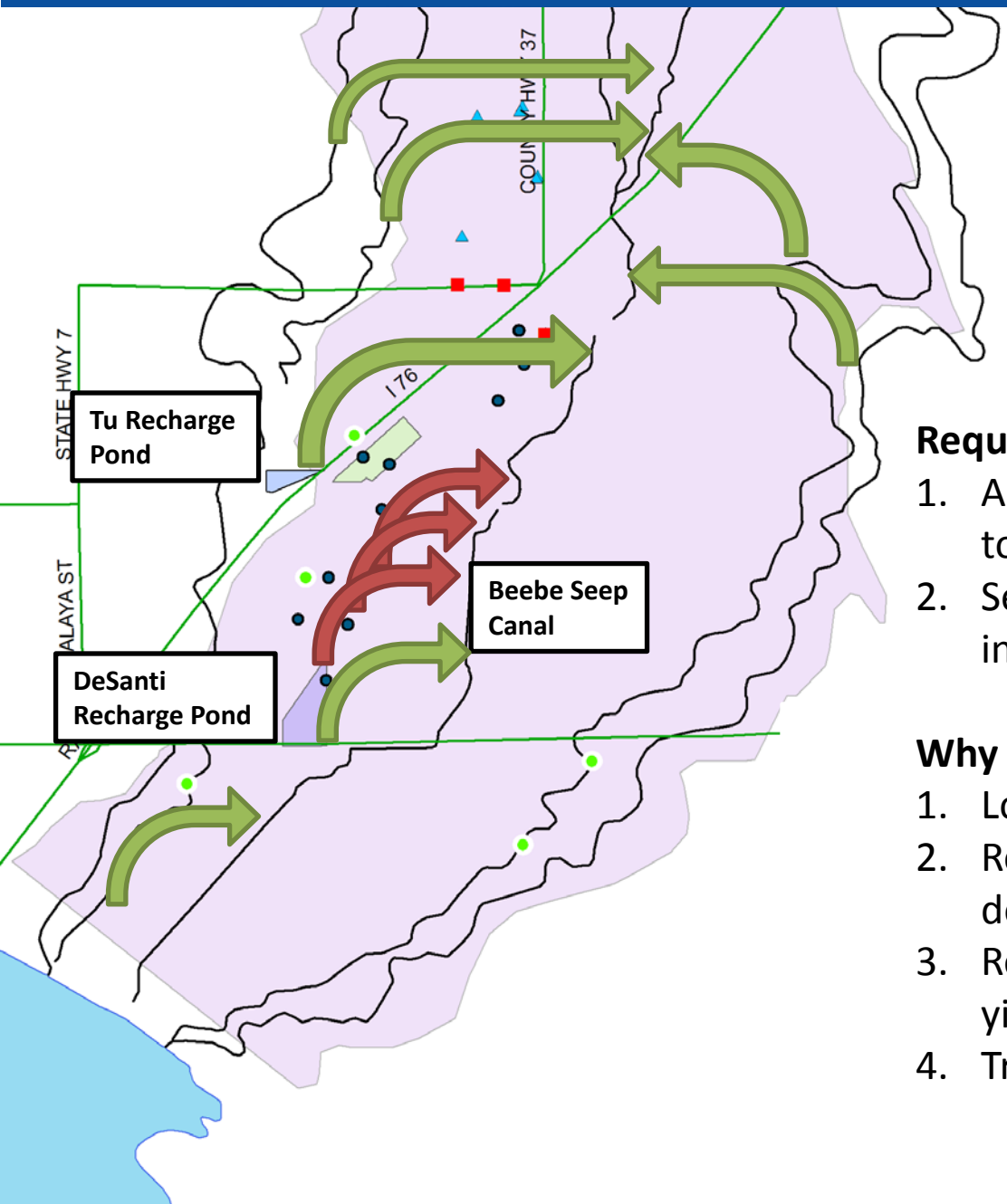
'Remaining Exchange Potential' updated after exchanges


Cache La Poudre
Big Thompson
St. Vrain
United No. 3 Reservoir

Zoom-In of Beebe Draw Alluvial Aquifer



Pumping Depletions and Recharge Accretions



Objects:

1. Each well has a decreed URF that determines depletions owed to Beebe Seep Canal
2. Each recharge pond and recharge canal has a URF that determines accretions to Beebe Seep Canal

Requirements:

1. All pumping depletions must be replaced to Beebe Seep Canal (in time and place)
2. Senior pumping rights must not be injured (aquifer drawdown)

Why recharge?

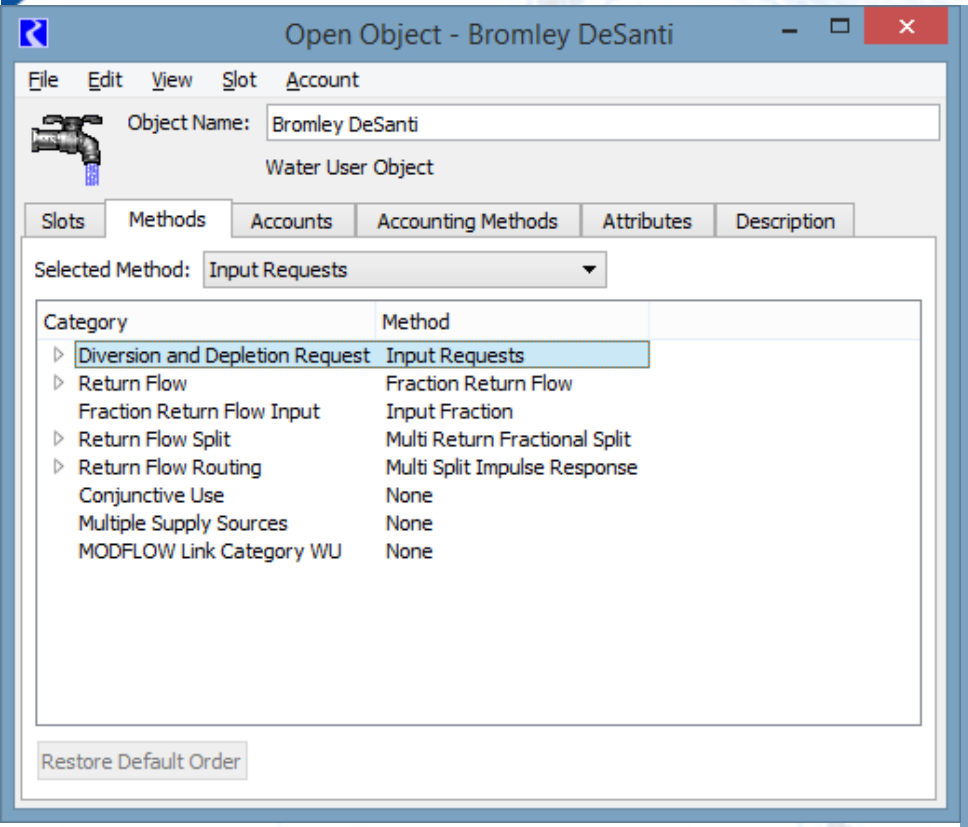
1. Lochbuie stipulation wells
2. Re-timing to smooth out summer demand curve
3. Re-timing to smooth out wet/dry year yields
4. Treatment filtration credit

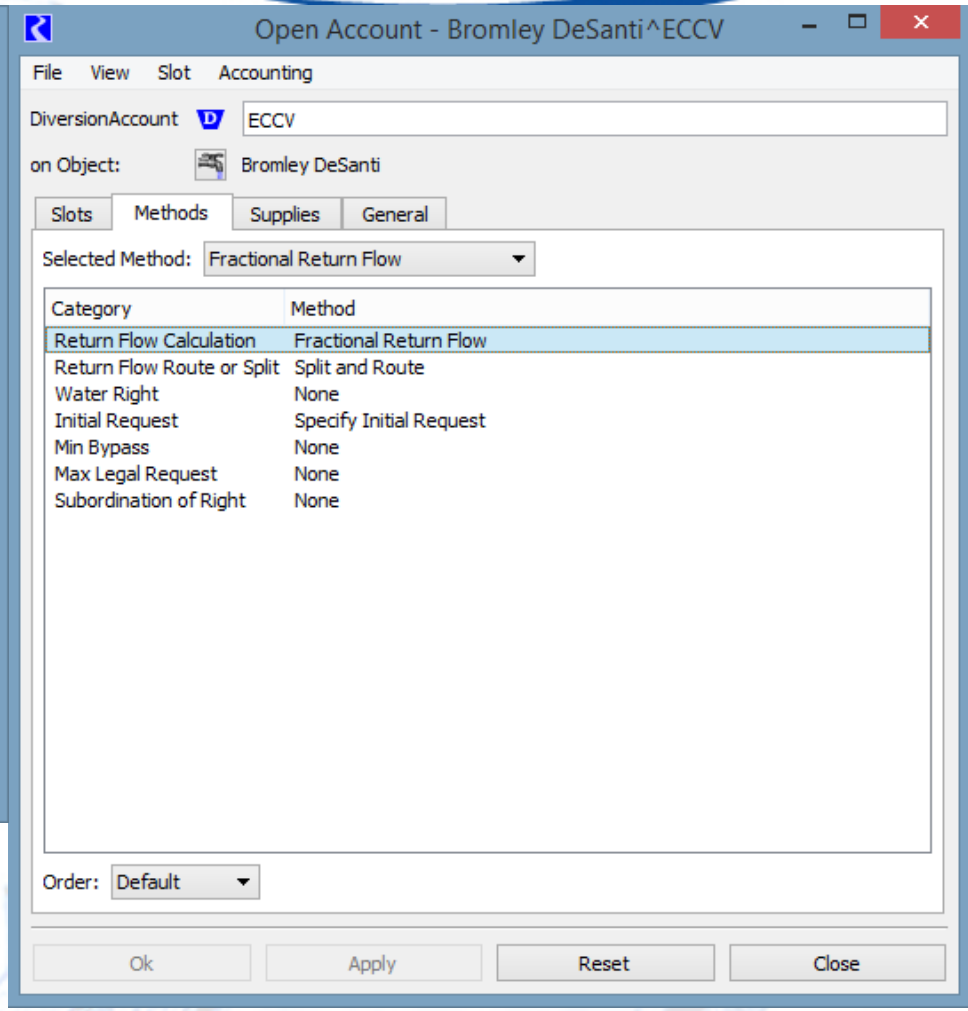
URF Calculations

			URF ---------->														
			7.05	16.34	12.59	8.69	6.50	5.21	4.35	3.74	3.27	2.89	2.57	2.29	2.06	1.85	1.67	1.5
BOM Day	Pumping (AF)	Depletion (AF)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1/1/2015	104.0	7.33	7.3															
2/1/2015	52.0	20.65	3.7	17.0														
3/1/2015	76.0	26.94	5.4	8.5	13.1													
4/1/2015	13.0	28.92	0.9	12.4	6.5	9.0												
5/1/2015	0.0	22.97	0.0	2.1	9.6	4.5	6.8											
6/1/2015	0.0	17.04	0.0	0.0	1.6	6.6	3.4	5.4										
7/1/2015	25.0	15.07	1.8	0.0	0.0	1.1	4.9	2.7	4.5									
8/1/2015	120.0	23.50	8.5	4.1	0.0	0.0	0.8	4.0	2.3	3.9								
9/1/2015	0.0	32.08	0.0	19.6	3.1	0.0	0.0	0.7	3.3	1.9	3.4							
10/1/2015	84.0	31.31	5.9	0.0	15.1	2.2	0.0	0.0	0.6	2.8	1.7	3.0						
11/1/2015	30.0	35.04	2.1	13.7	0.0	10.4	1.6	0.0	0.0	0.5	2.5	1.5						
12/1/2015	109.0	38.60	7.7	4.9	10.6	0.0	7.8	1.3	0.0	0.0	0.4	2.2	1.3	2.4				
1/1/2016	104.0	49.21	7.3	17.8	3.8	7.3	0.0	6.2	1.1	0.0	0.0	0.4	2.0	1.2	2.1			
2/1/2016	52.0	53.68	3.7	17.0	13.7	2.6	5.5	0.0	5.2	0.9	0.0	0.0	0.3	1.7	1.1	1.9		
3/1/2016	76.0	52.61	5.4	8.5	13.1	9.5	2.0	4.4	0.0	4.5	0.8	0.0	0.0	0.3	1.6	1.0	1.7	
4/1/2016	13.0	49.98	0.9	12.4	6.5	9.0	7.1	1.6	3.7	0.0	3.9	0.7	0.0	0.0	0.3	1.4	0.9	1
5/1/2016	0.0	40.91	0.0	2.1	9.6	4.5	6.8	5.7	1.3	3.1	0.0	3.5	0.6	0.0	0.0	0.2	1.3	0
6/1/2016	0.0	32.66	0.0	0.0	1.6	6.6	3.4	5.4	4.7	1.1	2.7	0.0	3.1	0.6	0.0	0.0	0.2	1
7/1/2016	25.0	28.86	1.8	0.0	0.0	1.1	4.9	2.7	4.5	4.1	1.0	2.4	0.0	2.8	0.5	0.0	0.0	0
8/1/2016	120.0	35.77	8.5	4.1	0.0	0.0	0.8	4.0	2.3	3.9	3.6	0.9	2.2	0.0	2.5	0.5	0.0	0
9/1/2016	0.0	43.06	0.0	19.6	3.1	0.0	0.0	0.7	3.3	1.9	3.4	3.1	0.8	1.9	0.0	2.2	0.4	0
10/1/2016	84.0	41.3	5.9	0.0	15.1	2.2	0.0	0.0	0.6	2.8	1.7	3.0	2.8	0.7	1.7	0.0	2.0	0
11/1/2016	30.0	43.2	2.1	13.7	0.0	10.4	1.6	0.0	0.0	0.5	2.5	1.5	2.7	2.5	0.6	1.6	0.0	1
12/1/2016	109.0	46.8	7.7	4.9	10.6	0.0	7.8	1.3	0.0	0.0	0.4	2.2	1.3	2.4	2.2	0.6	1.4	0
1/1/2017	104.0	50.47	7.3	17.8	3.8	7.3	0.0	6.2	1.1	0.0	0.0	0.4	2.0	1.2	2.1	2.0	0.5	1
2/1/2017	52.0	60.25	3.7	17.0	13.7	2.6	5.5	0.0	5.2	0.9	0.0	0.0	0.3	1.7	1.1	1.9	1.8	0
3/1/2017	76.0	58.57	5.4	8.5	13.1	9.5	2.0	4.4	0.0	4.5	0.8	0.0	0.0	0.3	1.6	1.0	1.7	1
4/1/2017	13.0	55.40	0.9	12.4	6.5	9.0	7.1	1.6	3.7	0.0	3.9	0.7	0.0	0.0	0.3	1.4	0.9	1
5/1/2017	0.0	45.84	0.0	2.1	9.6	4.5	6.8	5.7	1.3	3.1	0.0	3.5	0.6	0.0	0.0	0.2	1.3	0
6/1/2017	0.0	37.15	0.0	0.0	1.6	6.6	3.4	5.4	4.7	1.1	2.7	0.0	3.1	0.6	0.0	0.0	0.2	1
7/1/2017	25.0	32.95	1.8	0.0	0.0	1.1	4.9	2.7	4.5	4.1	1.0	2.4	0.0	2.8	0.5	0.0	0.0	0
8/1/2017	120.0	39.51	8.5	4.1	0.0	0.0	0.8	4.0	2.3	3.9	3.6	0.9	2.2	0.0	2.5	0.5	0.0	0
9/1/2017	0.0	46.48	0.0	19.6	3.1	0.0	0.0	0.7	3.3	1.9	3.4	3.1	0.8	1.9	0.0	2.2	0.4	0
10/1/2017	84.0	44.30	5.9	0.0	15.1	2.2	0.0	0.0	0.6	2.8	1.7	3.0	2.8	0.7	1.7	0.0	2.0	0
11/1/2017	30.0	46.79	2.1	13.7	0.0	10.4	1.6	0.0	0.0	0.5	2.5	1.5	2.7	2.5	0.6	1.6	0.0	1
12/1/2017	109.0	49.25	7.7	4.9	10.6	0.0	7.8	1.3	0.0	0.0	0.4	2.2	1.3	2.4	2.2	0.6	1.4	0
1/1/2018	104.0	58.88	7.3	17.8	3.8	7.3	0.0	6.2	1.1	0.0	0.0	0.4	2.0	1.2	2.1	2.0	0.5	1

ACCOUNTING NIGHTMARE

Return Flow Methods





Return Flow Methods

Speer Above DeSanti Seepage Diversion^ECCV.Multi Return Lag Coeffs

File Edit Row Column View Accounting Adjust

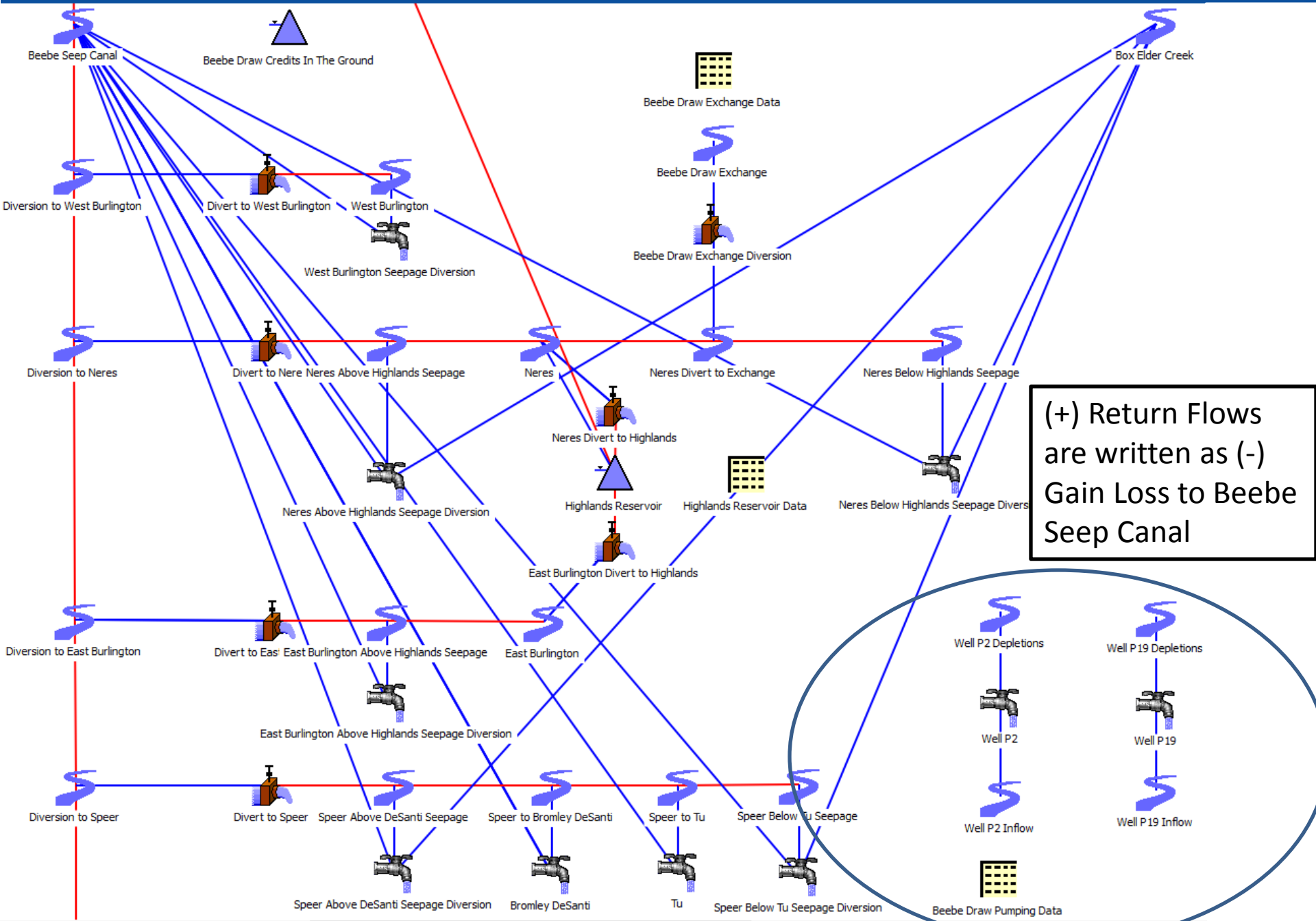
Multi Return Lag Coeffs

Value: 0.003048 decimal

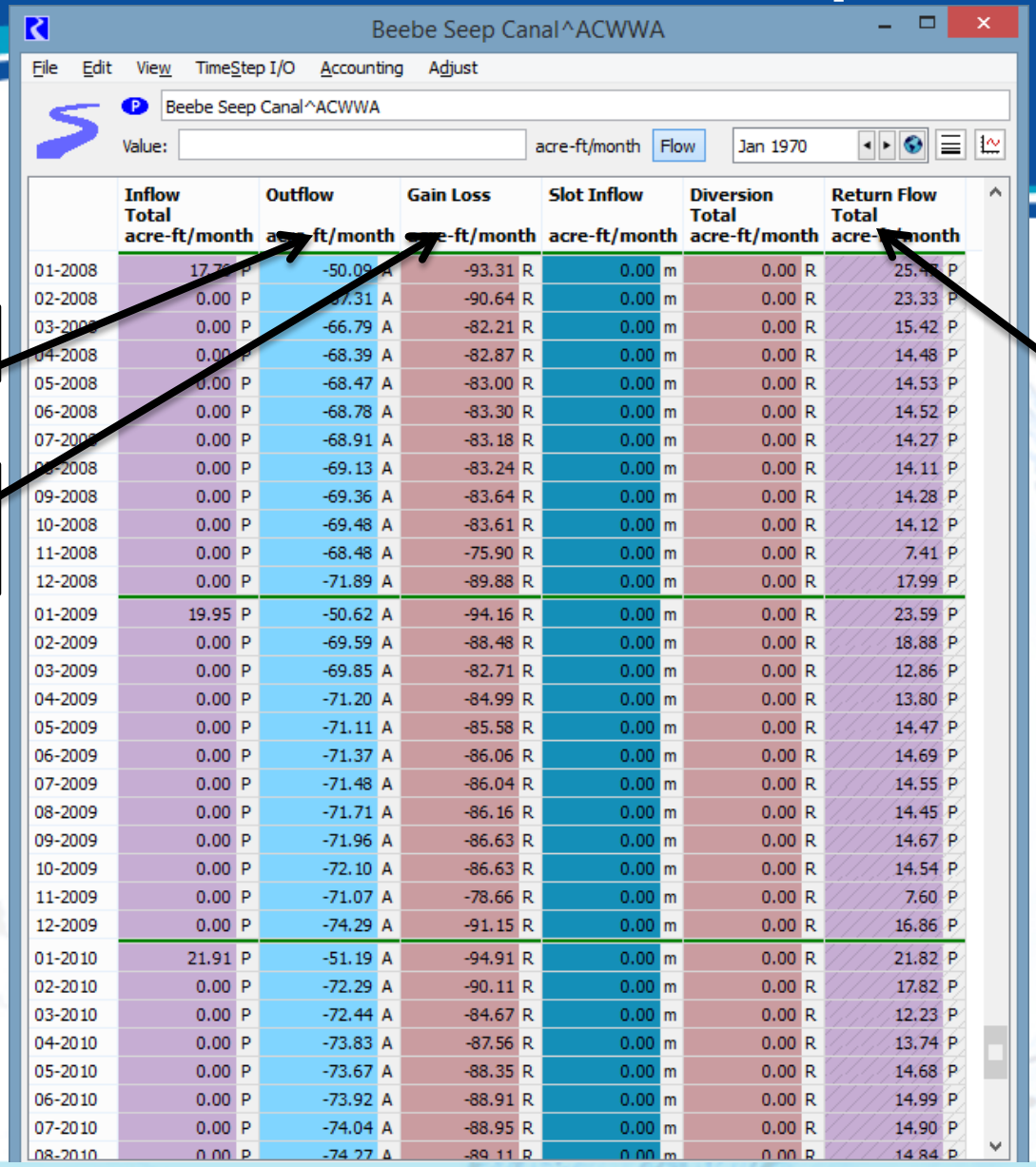
	Speer Above DeSanti Seepage Diversion ^ECCV Multi Return Lag Coeffs Speer Above DeSanti Seepage Diversion ECCV to Beebe Seep Canal ECCV Div Supply decimal	Speer Above DeSanti Seepage Diversion ^ECCV Multi Return Lag Coeffs Speer Above DeSanti Seepage Diversion ECCV to Box Elder Creek ECCV Div Supply decimal
1	0.07	0.00
2	0.06	0.00
3	0.04	0.00
4	0.03	0.00
5	0.02	0.00
6	0.02	0.00
7	0.01	0.00
8	0.01	0.00
9	0.01	0.00
10	0.01	0.00
11	0.01	0.00
12	0.01	0.00
13	0.01	0.00
14	0.01	0.00
15	0.01	0.00
16	0.00	0.00
17	0.00	0.00
18	0.00	0.00
19	0.00	0.00
20	0.00	0.00

↓ Recharge Pond or Well URF

Return Flow Methods



Net Accretions and Depletions



	Inflow Total acre-ft/month	Outflow acre-ft/month	Gain Loss acre-ft/month	Slot Inflow acre-ft/month	Diversion Total acre-ft/month	Return Flow Total acre-ft/month
01-2008	17.79 P	-50.09 A	-93.31 R	0.00 m	0.00 R	25.47 P
02-2008	0.00 P	-67.31 A	-90.64 R	0.00 m	0.00 R	23.33 P
03-2008	0.00 P	-66.79 A	-82.21 R	0.00 m	0.00 R	15.42 P
04-2008	0.00 P	-68.39 A	-82.87 R	0.00 m	0.00 R	14.48 P
05-2008	0.00 P	-68.47 A	-83.00 R	0.00 m	0.00 R	14.53 P
06-2008	0.00 P	-68.78 A	-83.30 R	0.00 m	0.00 R	14.52 P
07-2008	0.00 P	-68.91 A	-83.18 R	0.00 m	0.00 R	14.27 P
08-2008	0.00 P	-69.13 A	-83.24 R	0.00 m	0.00 R	14.11 P
09-2008	0.00 P	-69.36 A	-83.64 R	0.00 m	0.00 R	14.28 P
10-2008	0.00 P	-69.48 A	-83.61 R	0.00 m	0.00 R	14.12 P
11-2008	0.00 P	-68.48 A	-75.90 R	0.00 m	0.00 R	7.41 P
12-2008	0.00 P	-71.89 A	-89.88 R	0.00 m	0.00 R	17.99 P
01-2009	19.95 P	-50.62 A	-94.16 R	0.00 m	0.00 R	23.59 P
02-2009	0.00 P	-69.59 A	-88.48 R	0.00 m	0.00 R	18.88 P
03-2009	0.00 P	-69.85 A	-82.71 R	0.00 m	0.00 R	12.86 P
04-2009	0.00 P	-71.20 A	-84.99 R	0.00 m	0.00 R	13.80 P
05-2009	0.00 P	-71.11 A	-85.58 R	0.00 m	0.00 R	14.47 P
06-2009	0.00 P	-71.37 A	-86.06 R	0.00 m	0.00 R	14.69 P
07-2009	0.00 P	-71.48 A	-86.04 R	0.00 m	0.00 R	14.55 P
08-2009	0.00 P	-71.71 A	-86.16 R	0.00 m	0.00 R	14.45 P
09-2009	0.00 P	-71.96 A	-86.63 R	0.00 m	0.00 R	14.67 P
10-2009	0.00 P	-72.10 A	-86.63 R	0.00 m	0.00 R	14.54 P
11-2009	0.00 P	-71.07 A	-78.66 R	0.00 m	0.00 R	7.60 P
12-2009	0.00 P	-74.29 A	-91.15 R	0.00 m	0.00 R	16.86 P
01-2010	21.91 P	-51.19 A	-94.91 R	0.00 m	0.00 R	21.82 P
02-2010	0.00 P	-72.29 A	-90.11 R	0.00 m	0.00 R	17.82 P
03-2010	0.00 P	-72.44 A	-84.67 R	0.00 m	0.00 R	12.23 P
04-2010	0.00 P	-73.83 A	-87.56 R	0.00 m	0.00 R	13.74 P
05-2010	0.00 P	-73.67 A	-88.35 R	0.00 m	0.00 R	14.68 P
06-2010	0.00 P	-73.92 A	-88.91 R	0.00 m	0.00 R	14.99 P
07-2010	0.00 P	-74.04 A	-88.95 R	0.00 m	0.00 R	14.90 P
08-2010	0.00 P	-74.27 A	-89.11 R	0.00 m	0.00 R	14.84 P

Net depletions

Pumping Depletions

Recharge accretions