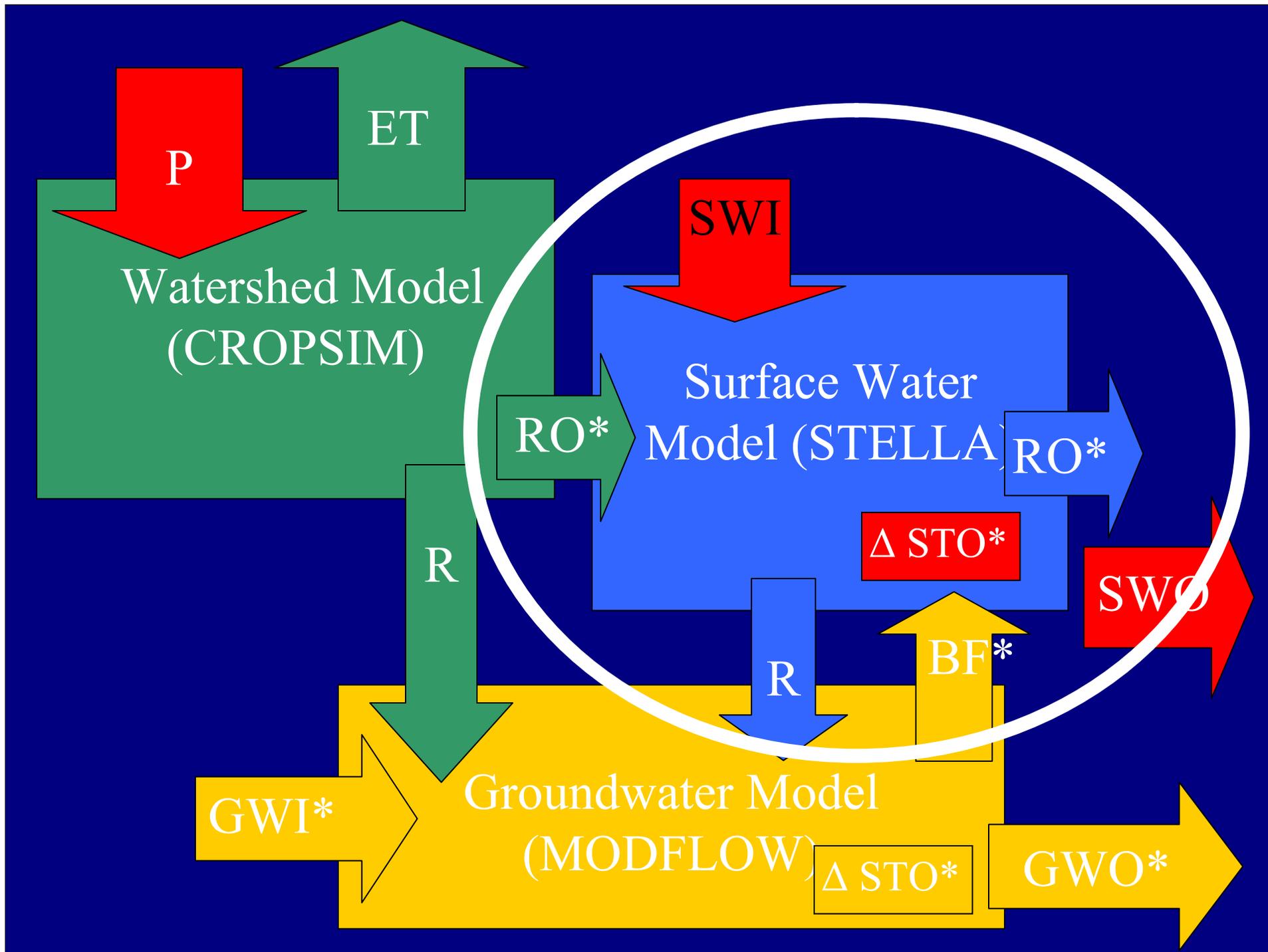
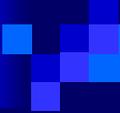


# COHYST 2010

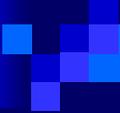
## The Surface Water Operations Model





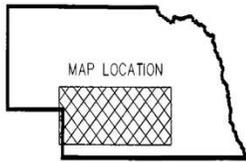
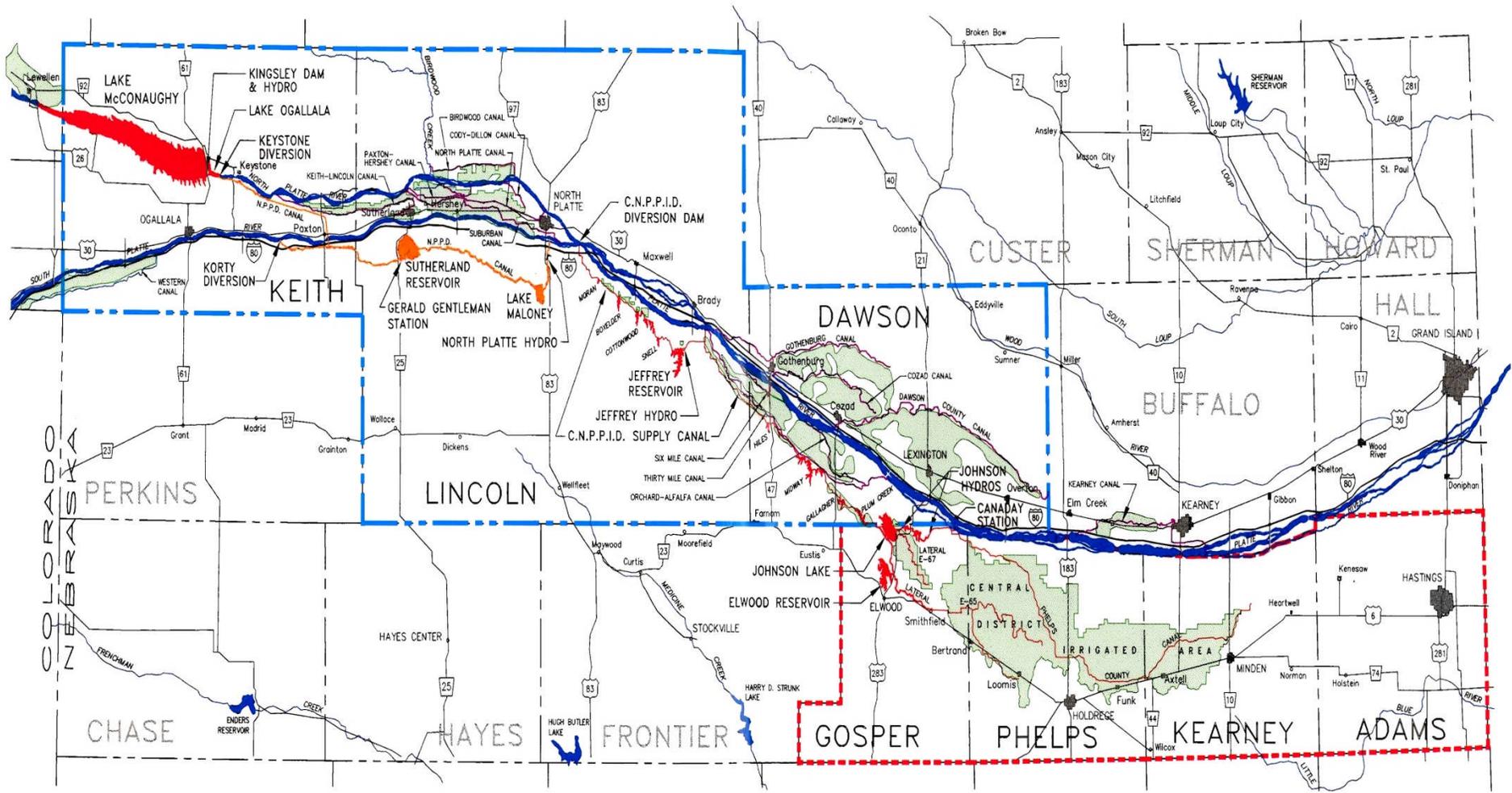
# Surface Water Operations Model - STELLA

- Simple to Complex Systems
- Flexible tool and user-friendly
- Transparent and easy to understand
- Ideal for consensus building process

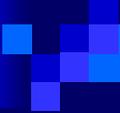


# Surface Water Operations Model - STELLA

- Object oriented network construction
  - Reservoirs
  - Streams, Diversions, and Returns
  - Canals
  - Losses and Gains
  - Hydropower
- Rules and operations customized
  - Water Rights and Priorities
  - Natural Flows and Storage Flows
- Excellent data handling ability
  - Daily time step handled easily
- Excellent graphic capabilities



SURFACE IRRIGATION



# Model Physical Components

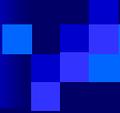
- River Reaches
- Canal Diversions>Returns
- Reservoirs
- Hydropower

# Platte River Gages

Platte River Gages	Period of Record
Duncan	1954-present
Grand Island	1954-present
Odessa	1954-present
Overton	1954-present
Cozad	1954-present
Brady	1954-present
North Platte (S. Platte and N. Platte)	1954-present
Roscoe	1982-present
Julesburg	1954-present
Sutherland	1954-present
Keystone	1954-present
Lewellen	1954-present

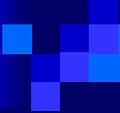
# Canals

North Platte Canals	Platte Canals
Keith Lincoln Canal	Tri County Canal - CNPPID Supply Canal
North Platte Canal	Phelps County Canal
Paxton Hershey Canal	E65 Canal
Suburban Canal	E67 Canal
Cody Dillon Canal	Gothenburg Canal
Birdwood Canal	Cozad Canal
Keystone Canal	Dawson County Canal
South Platte Canals	Thirty Mile Canal
Western Canal	Six Mile Canal
Korty/Sutherland Canal	Orchard Alfalfa Canal
	Kearney Canal



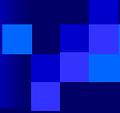
# Reservoirs

- Lake McConaughy/Lake Ogallala
- Sutherland Reservoir
- Lake Maloney
- Jeffrey Lake
- Johnson Lake
- Elwood Reservoir
- B1 Reservoir
- Kearney Reservoir



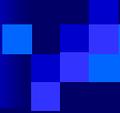
# Hydropower

- Kingsley Hydropower
- North Platte Hydropower
- Jeffrey Hydropower
- J1 & J2 Hydropower
- Kearney Hydropower



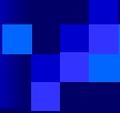
# Modeling Parameters

- 1985 – 1997 Calibration
- 1998 – 2005 Verification
- Daily Time Step
- External Boundary Conditions/Inputs
  - Lake McConaughy Inflow
  - Julesburg Gage
  - Initial Baseflow & Runoff Estimates



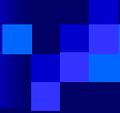
# Internal Operators/Functions

- Operating Rules
- Canal/Reservoir Seepage
- Time Lags
- Reach Gain/Loss



# Operating Rules - Reservoirs

- Lake McConaughy/Lake Ogallala
- Sutherland Reservoir
- Lake Maloney
- Jeffrey Lake
- Johnson Lake
- Elwood Reservoir
- B1 Reservoir
- Kearney Reservoir



# Operating Rules - Diversions

- Keystone/Korty Diversions
- Tri-County Diversion
  - Jeffrey Return
  - E-65
  - E-67
  - Phelps/J-2
- Kearney Lake
- Irrigation Canals (largely historical patterns)

# Canal Seepage

## ■ Canal Seepage

- Limited Data for Seepage Rates

- Seepage estimates:

- Synoptic Studies conducted on a few of the NPPD canals
- Historic diversion patterns
- Two different rates used during seasoning (pre-June 15) and irrigation season (post-June 15)



# Canal Seepage

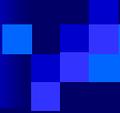
- Canal Seepage – Temporal Distribution
  - 50% of first two weeks diversion
  - Average pre-June 15 diversion used to determine seepage rate
  - Synoptic Study Results used during irrigation season (43% losses)
    - 1% Evaporation
    - 10% Spills
    - 32% Seepage

# Canal Seepage - Summary

Canal	Irrigation Water Use [-]	Net Evaporation [% of diversions] <sup>2</sup>	Spills [% of diversions] <sup>2</sup>	Canal Seepage			
				Early Season		Irrigation Season	
				First Two Weeks Canal Filling [% of diversions]	From Canal Full to June 15 [cfs] <sup>1</sup>	OPTION 1 June 16 to End of Season [cfs] <sup>1</sup>	OPTION 2 June 16 to End of Season [% of diversions] <sup>2</sup>
Keith Lincoln Canal	0 (data pending)	1%	10%	50%	29 cfs	24 cfs	32%
North Platte Canal	0 (data pending)	1%	10%	50%	72 cfs	71 cfs	32%
Paxton Hershey Canal	0 (data pending)	1%	10%	50%	31 cfs	27 cfs	32%
Suburban Canal	0 (data pending)	1%	10%	50%	36 cfs	23 cfs	32%
Cody Dillon Canal	0 (data pending)	1%	10%	50%	5 cfs	6 cfs	32%
Birdwood Canal	0 (data pending)	1%	10%	50%	14 cfs	8 cfs	32%
Western Canal <sup>1</sup>	0 (data pending)	1%	10%	50%	63 cfs	26 cfs	32%
Keystone/Korty/Sutherland Canal	0	Varies by reach (0.2% to 0.5%)	IF flow > capacity, THEN flow - capacity	Two Options: (1) Default = constant rates, variable by month, based on 2002-2003 Republican River Study mass balances. (2) Canal reach seepage constant rate all year, based on 1993 Harza study; reservoir seepage based on constant or equation from NPPD.			
Tri County Canal aka CNPPID Supply Canal <sup>1</sup>	0	Combined with Seepage.	0	For four reaches of Supply Canal, seepage + evap vary as function of flow rate in canal. In STELLA, evap component separated using "Gothenburg" pan evap and precip, which is average of North Platte and Grand Island stations.			
Phelps County Canal <sup>1,7</sup>	0 (data pending)	1%	2%	50%	250 cfs	450 cfs	TBD
E65 Canal <sup>1,7</sup>	0 (data pending)	1%	2%	50%	75 cfs	140 cfs	TBD
E67 Canal <sup>1,7</sup>	0 (data pending)	1%	2%	50%	20 cfs	35 cfs	TBD
Gothenburg Canal <sup>1</sup>	Based on Groff annual demands <sup>2</sup>	1%	10%	65%	90 cfs	95 cfs	32%
Cozad Canal	Based on Groff annual demands <sup>2</sup>	1%	10%	50%	31 cfs	64 cfs	32%
Dawson County Canal	Based on Groff annual demands <sup>2</sup>	1%	10%	50%	103 cfs	117 cfs	32%
Thirty Mile Canal	Based on Groff annual demands <sup>2</sup>	1%	10%	50%	72 cfs	77 cfs	32%
Six Mile Canal	Based on Groff annual demands <sup>2</sup>	1%	10%	50%	3 cfs	7 cfs	32%
Orchard Alfalfa Canal	Based on Groff annual demands <sup>2</sup>	1%	10%	50%	16 cfs	17 cfs	32%
Kearney Canal <sup>8</sup>	57%	1%	10%	32% from 4/22 to 10/25 (average start and end dates for diversions)			
Kearney Power Return	0	1%	10%	32% from 4/22 to 10/25 (average start and end dates for diversions)			

## NOTES:

- Irrigation demand sectors are set up in STELLA (except for CNPPID system). Waiting for annual demands from Marc Groff to distribute and populate STELLA converters.
- Percentages based on CPNRD/NPPD Gothenburg Canal system synoptic study (See Note #4 for Gothenburg variation).
- Constant seepage rates in cfs based on analysis in files:  
 Gothenburg\_AvgHistoricDiversion\_Revised102408.xls;  
 PlatteCanals\_EarlySeasonDiversionSeepagePatterns\_Revised102908.xls  
 PlatteCanals\_IrrigationSeasonSeepageEstimates\_Revised102908.xls  
 DRAFT\_PlatteCanals\_SeepageDocumentation\_Revised102908.doc
- Gothenburg early season constant seepage based on analysis in file "Gothenburg\_AvgHistoricDiversion\_Revised102408.xls." Irrigation season constant rate based on synoptic study data.
- Annual irrigation demands developed by Marc Groff of the Flatwater Group. Distributed to daily using 1985-1997 daily average historical diversion pattern as effective "unit curve."
- Seepage + Evap values for CNPPID Supply Canal provided by Cory Steinke of CNPPID, in file "Supply Canal losses by reach and diversion.xls"
- Evap and Seepage percentages for CNPPID irrigation canals based on Engel/MacEwan/Turner conference call on 12/08/08.
- Kearney Canal irrigation water use = 57% of diversions, such that irrigation (57%) + evap (1%) + spills (10%) + seepage (32%) = 100%.

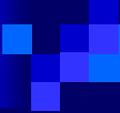


# Reservoir Seepage

- Water Budget Analysis used to estimate average seepage rates
- Exception is Sutherland with stage-dependent function

# Lag Times

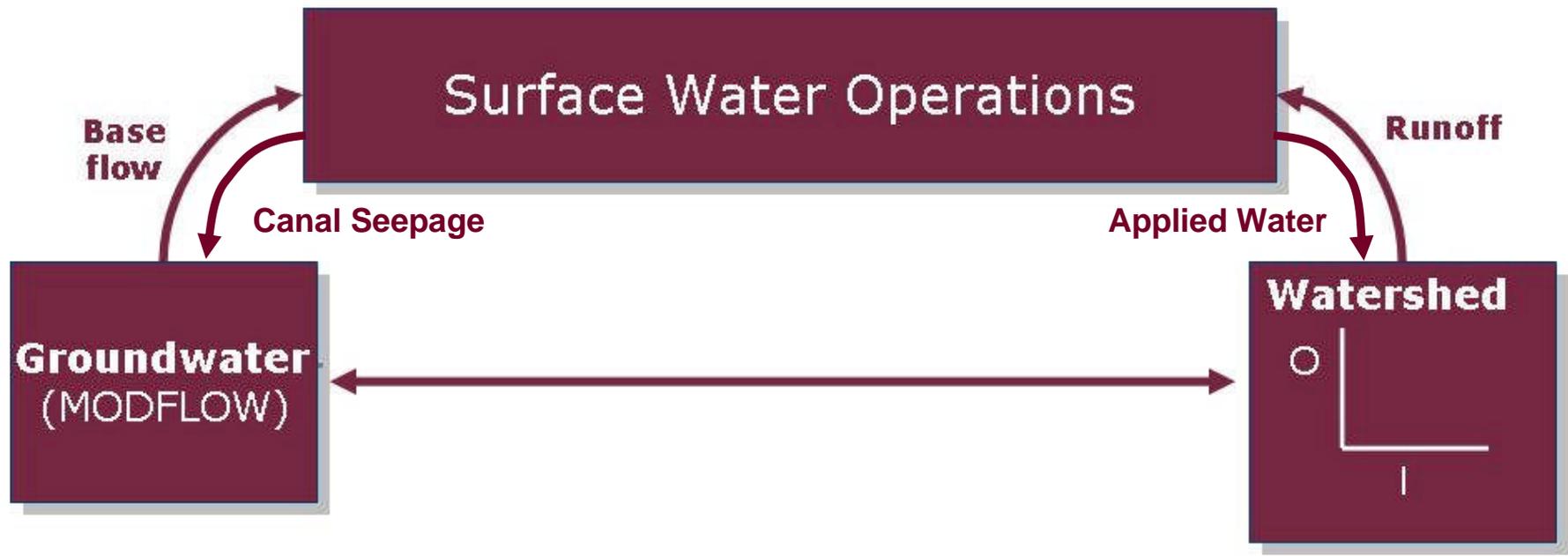
Location	Travel Days (from McConaughy / Western )
North Platte River @ Keystone Canal Diversion	0
North Platte River, Downstream of Keystone Canal Diversion	0
North Platte River, Downstream of Birdwood Creek	1
Western Canal Diversion – South Platte River	0
Korty Canal Diversion – South Platte River	1
Platte River @ Tri-County Diversion	2
Platte River @ Gothenburg Canal Diversion	3
Platte River @ Cozad Canal Diversion	4
Platte River @ Dawson County Canal Diversion	4
Platte River @ Overton	5
Platte River @ Overton	5
Platte River @ Kearney Canal Diversion	6
Platte River @ Odessa	6
Platte River @ Grand Island	7
Platte River @ Duncan	8

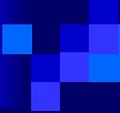


# Reach Gains and Losses

- Partitioned
  - Net Evaporation
  - Baseflow
  - Watershed Runoff
- Initial estimates based on baseflow separation work

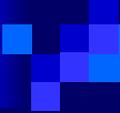
# 'Handshake' with Watershed and Groundwater Models





# Watershed Model Handshake

- Watershed to SW Operations:
  - Crop Irrigation Surface Water Demands
  - Watershed Runoff
- SW Operations to Watershed:
  - Available Surface Water to meet crop demands

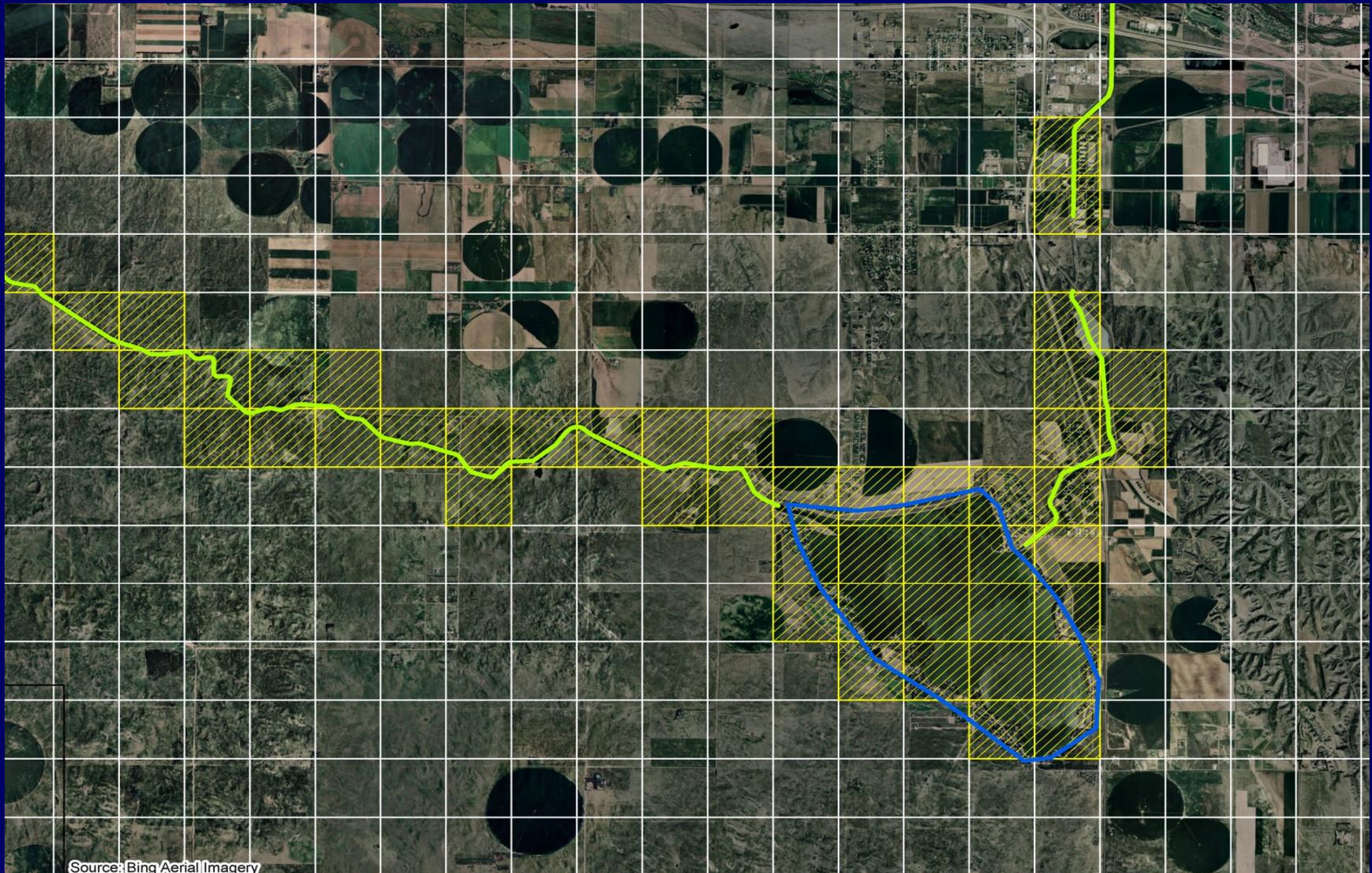


# Groundwater Model Handshake

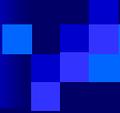
- GW to SW Operations:
  - Baseflow
- SW Operations to GW:
  - Recharge from Canals and Reservoirs



# Recharge Data Transfer

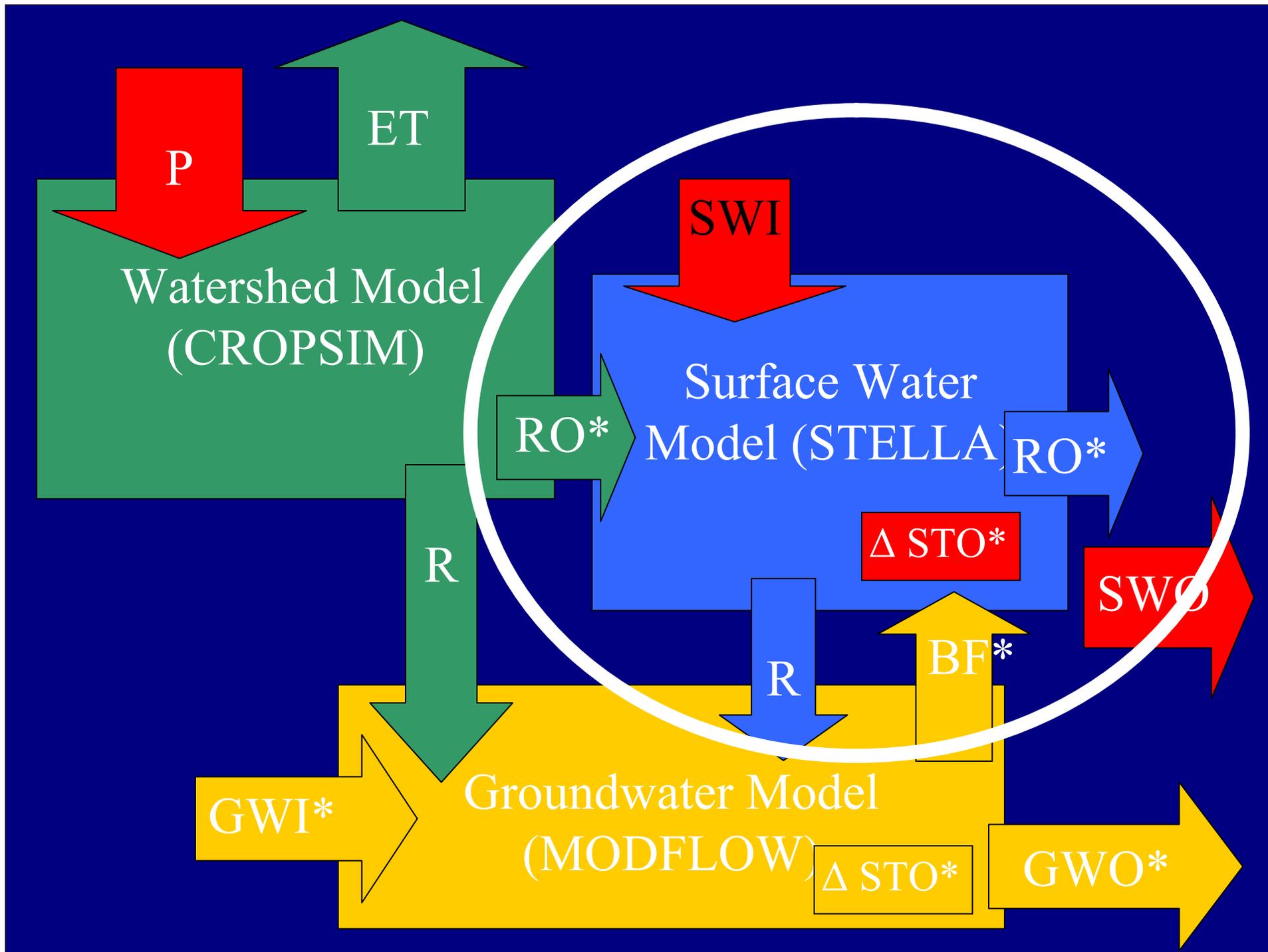


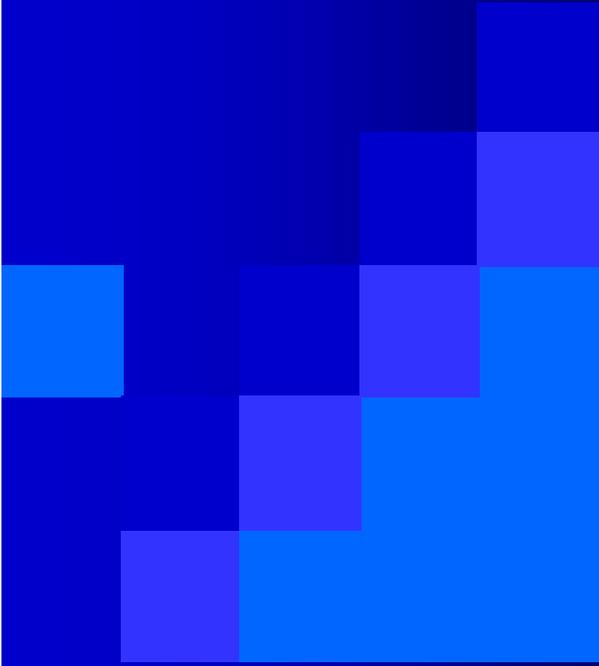
Source: Bing Aerial Imagery



# Calibration Targets

- Total Gage Flows
- Reservoir Stages
- Canal Diversions





Questions?