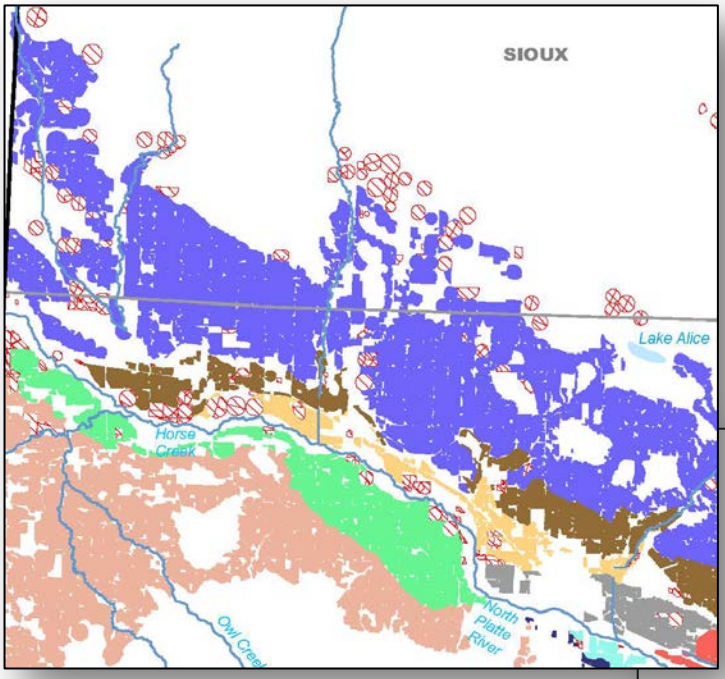
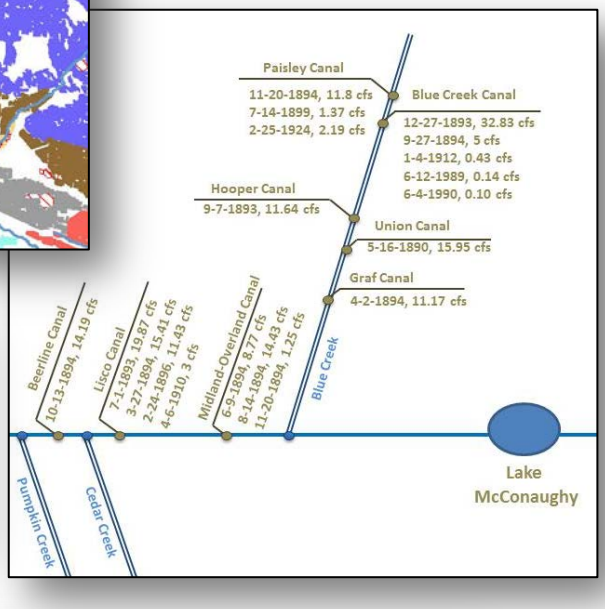
Western Water Use Management Model
StateMod Training Session

March 11, 2015





Session Overview

WWUM Model Component Interaction

WWUM Model Documentation

Data Management Interfaces

Modeling Directory Structure

StateMod Overview

- Control & Network File Development
- Streamflow Gage Input File Development
- Diversion Structure Input File Development
- Consumptive Use Input Files – StateCU Interaction
- Reservoir Input File Development
- Additional Input Files
- Operating Rules
- Inflow Hydrology

Running StateMod

StateMod Model Output Files

Calibration Results

Discussion Topics and Future Scenarios

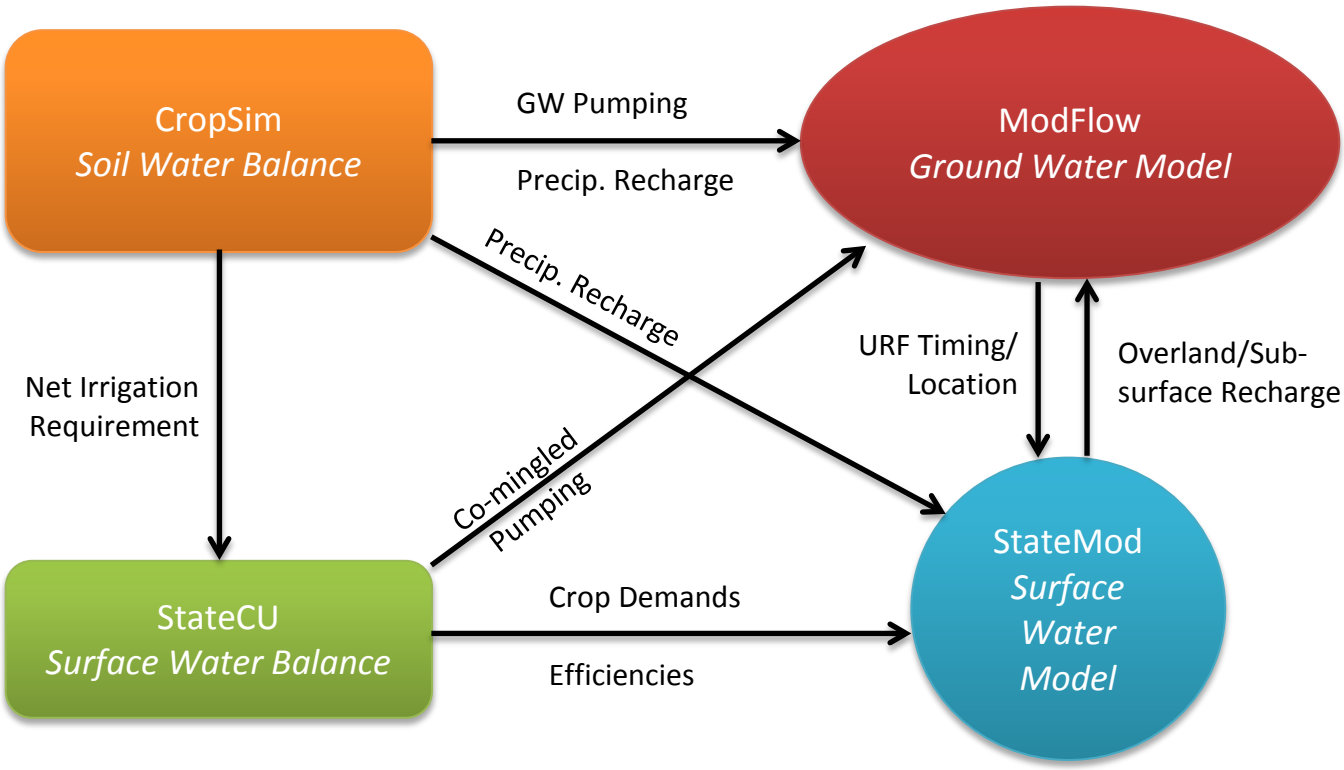
WWUM Model Component Interaction

CropSim – regionalized soil water balance model that provides estimates of net irrigation requirement (NIR) based on climate, land use, soil properties, crop types and irrigation practices.

StateCU – surface water balance model that reads in NIR and estimates the supply limited consumptive use and historical co-mingled pumping based on estimates of historical diversions, conveyance and application efficiency, irrigation practices, and soil properties.

StateMod – surface water allocation model that reads in irrigation, reservoir, and ground water demands and simulates diversions and pumping to meet those demands based on the Prior Appropriation administration system.

ModFlow – ground water model that simulates alluvial and streamflow conditions based on soil properties, precipitation and irrigation recharge, crop consumptive use, and ground water pumping.



WWUM Model Documentation

- The **WWUM Irrigated and Dryland Acreage Assessment** report describes the development of the 1953, 1975/77, 1984, 1993, 1997, 2001, 2005 and 2010 irrigated lands coverages, including the process used to determine irrigated acreage, associated crop type, irrigation method (sprinkler or flood), and surface water source.

- The **WWUM Regionalized Soil Water Balance Model (CropSim)** report describes the development of the climate data and soil moisture parameters, as well as the effective precipitation and consumptive use methodologies used to estimate potential consumptive use and net irrigation requirement for the entire WWUM study area.

- **WWUM Historical Consumptive Use Report** describes the development of the North Platte River Basin StateCU consumptive use model. This document, revised in July 2014, summarizes the process and results of developing the irrigation water requirement by modeled structure used in the Baseline Model, and the on-farm water balance components used to estimate actual crop consumptive use.

- The **Ground Water Flow Model for the Southern Half of the Nebraska Panhandle** describes the development of the MODFLOW ground water model for the North Platte and South Platte NRD areas. This document summarizes the process of integrating historical pumping and recharge information, as well as the model development process and the results from the model.

Data Management Interfaces

DMI's read commands to create formatted input files, as well as read output files. The DMI's are available for download from the Colorado Decision Support System website (cdss.state.co.us)

StateDMI – generally used to create files that contain physical properties associated with structures and stations, including water rights information.

TSTool – generally used to create files that contain time-series data associated with structures and stations, including streamflow measurements, acreage, and diversion records.

Data-centered = Command Driven. Command files are developed to create and format the input files required for StateCU and StateMod.

- Input files can be easily revised or updated to include additional periods
- Input files can be reproduced
- Input files are transparent and self-documenting because each command use to create an input file is stamped in the header

Data-centered command files use the following general approach to create each StateCU and StateMod input file:

1. "**Read**" information from HydroBase or another external database source
2. "**Set**" missing information or overwrite incorrect data
3. "**Fill**" missing time-series data using monthly averages, regression relationships, etc.
4. "**Write**" information to create the input file

To facilitate the data-centered approach and allow command files and model input files to be shared and easily updated, modelers have adopted a standard File Directory and file naming convention.

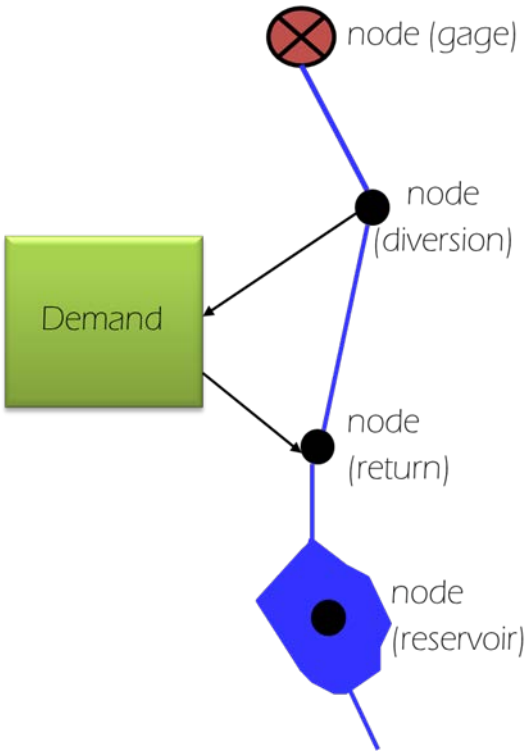
Standard file extensions are referenced throughout this and other CDSS documentation. These are recommended extensions for consistency and to facilitate file sharing.

Modeling Directory Structure

Directory	Application(s)	Description of Files Creating
.\StreamSW	SW	Stream files associated with StateMod, the surface water model. Stream stations (*.ris). Historical stream flow time series (monthly *.rih and daily .rid), stream estimate coefficients (*.rib), etc.
.\Diversions\Delay	SW	Tables used to set accretion/depletion locations and timing (*.rtn) used to develop station files.
.\Diversions	SW, CU and GW	Diversion station (*.dds) and rights (*.ddr). Monthly historical diversions (*.ddh) and demand time series (*.ddm). Daily historical diversions and demand time series (*.ddd). Surface water aggregation and multi-structure lists.
.\Instream	SW	Instream Flow station (*.ifs) and rights (*.ifr). Instream demands (average monthly *.ifa, monthly *.ifm and daily *.ifd)
.\Reservoir	SW	Reservoir station (*.res) and rights (*.rer). End of Month Content (*.eom) and Target Time Series (*.tam). Evaporation files (*.eva)
.\Wells	SW and CU	Well station (*.wes) and rights (*.wer). StateMod Historic time series (*.weh) and Demand time series (*.wem). StateCU historic pumping time series (*.gwp). Well aggregation parcel lists.
.\Network	SW	StateMod network (*.net).
.\DocSW	SW	Documentation associated with a Surface Water Application
.\StateMod	***SW***	***StateMod Model Files (all input and output data for a surface water application)***
.\Crops	CU	Crop Characteristics (*.cch), Crop Coefficients (*.kbc), and Crop acreage distribution (*.cds).
.\Location	CU	CU location (*.str) and Irrigation time series (*.ipy). Climate station assignment list. Soil AWC assignment list. Efficiency assignment list.
.\DocCU	CU	Documentation associated with a Consumptive Use Application
.\StateCU	***CU***	***StateCU Model Files (all input and output data for a surface water application)***

StateMod Overview

StateMod is a general purpose surface water allocation model that simulates diversions to meet a demand based on the Prior Appropriation administration system. It can be adapted to any river basin through unique user-supplied data sets; the data set defines the basin. Complete data sets are required; missing data need to be estimated for input files. StateMod operates on a linked node network; nodes are locations where you have or need information.



- Stream Gages
- Diversion Points
- Reservoirs
- Return Flow/Discharge Locations
- Return Flow Obligation Locations

StateMod Key Points:

- Natural flow is the amount of water that would be present if man wasn't there.
- Operates based on Prior Appropriation, identifies most senior water right in the model.
- Allocates water based on the minimum of (demand, water right, capacity, available flow).
- Future scenarios are based on hydrology as if it were to occur again in the future, hydrology is not projected.
- Operating rules are necessary for anything more complex than a direct diversion to a demand.

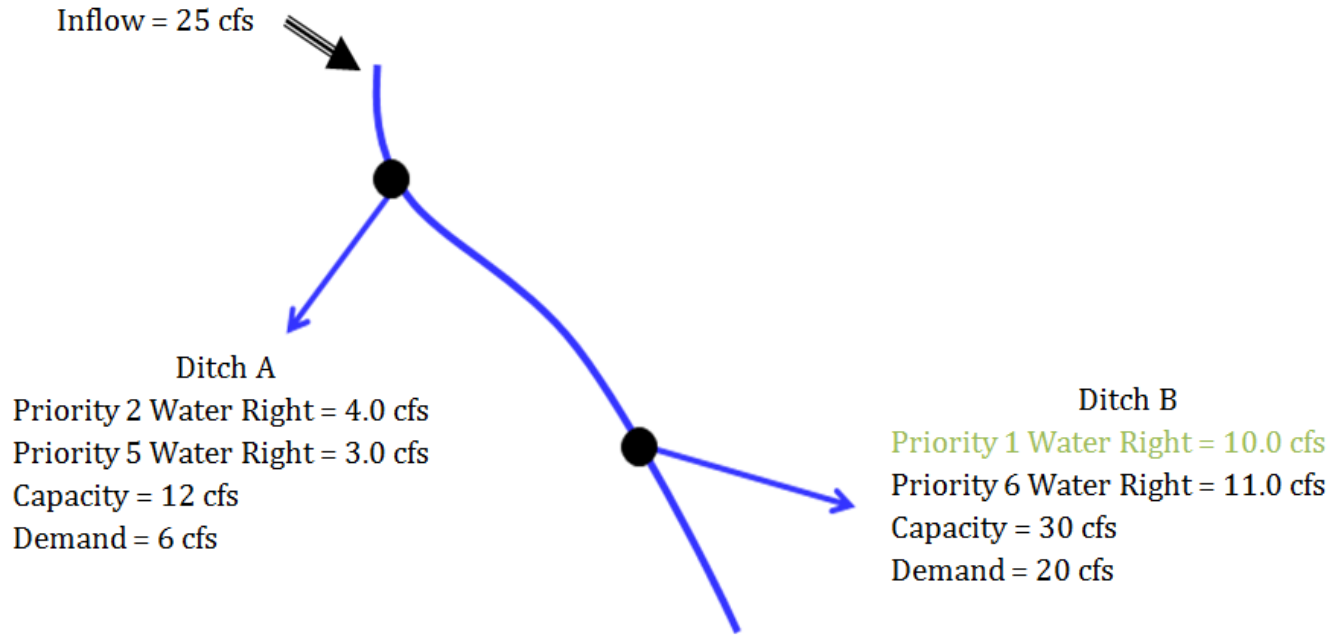
Model Components

Model Operations

StateMod operates based on the **Modified Direct Solution Algorithm**.
See Section 7.9 in the StateMod Documentation for more information.

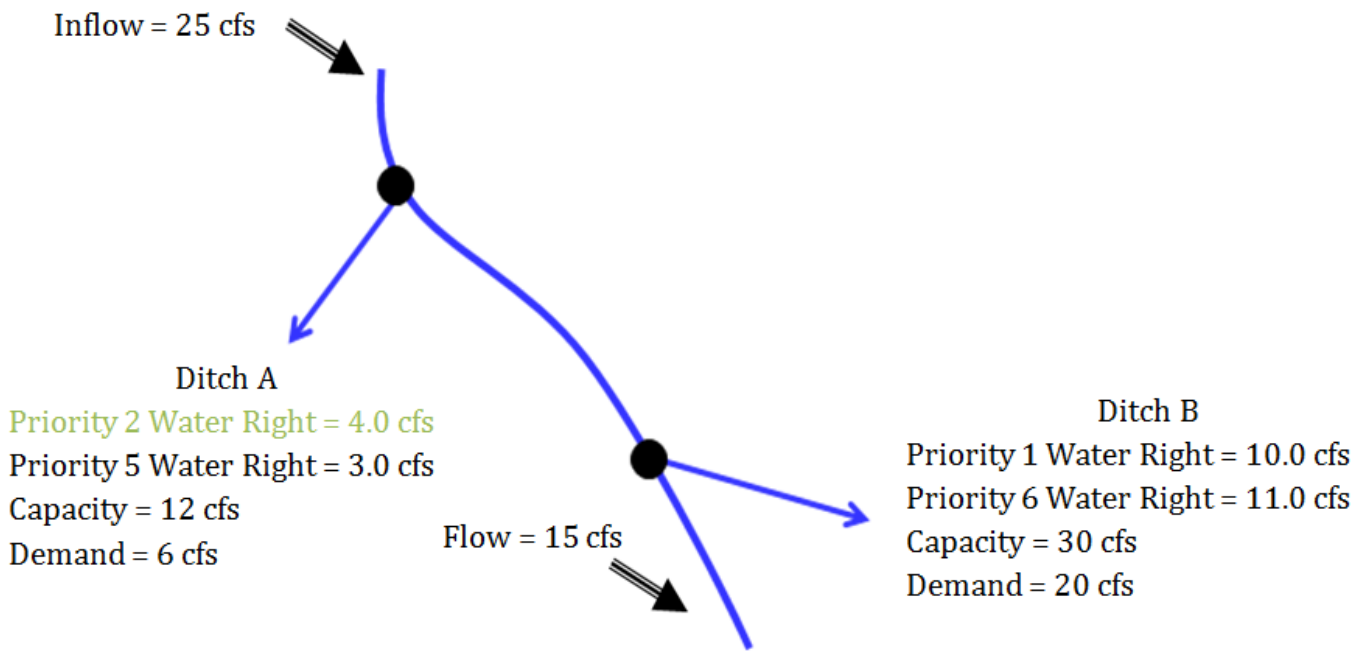
1. Identify most senior water right in the model
2. With natural inflow and/or return flows from previous time steps included, estimate the diversion amount based on the minimum of:
    - Demand
    - Water Right
    - Structure Capacity
    - Available Flow
3. Adjusts downstream flows to reflect senior diversions and immediate return flows
4. Future return flows are calculated
5. Repeated for next junior water right

StateMod Simulation, Step 1



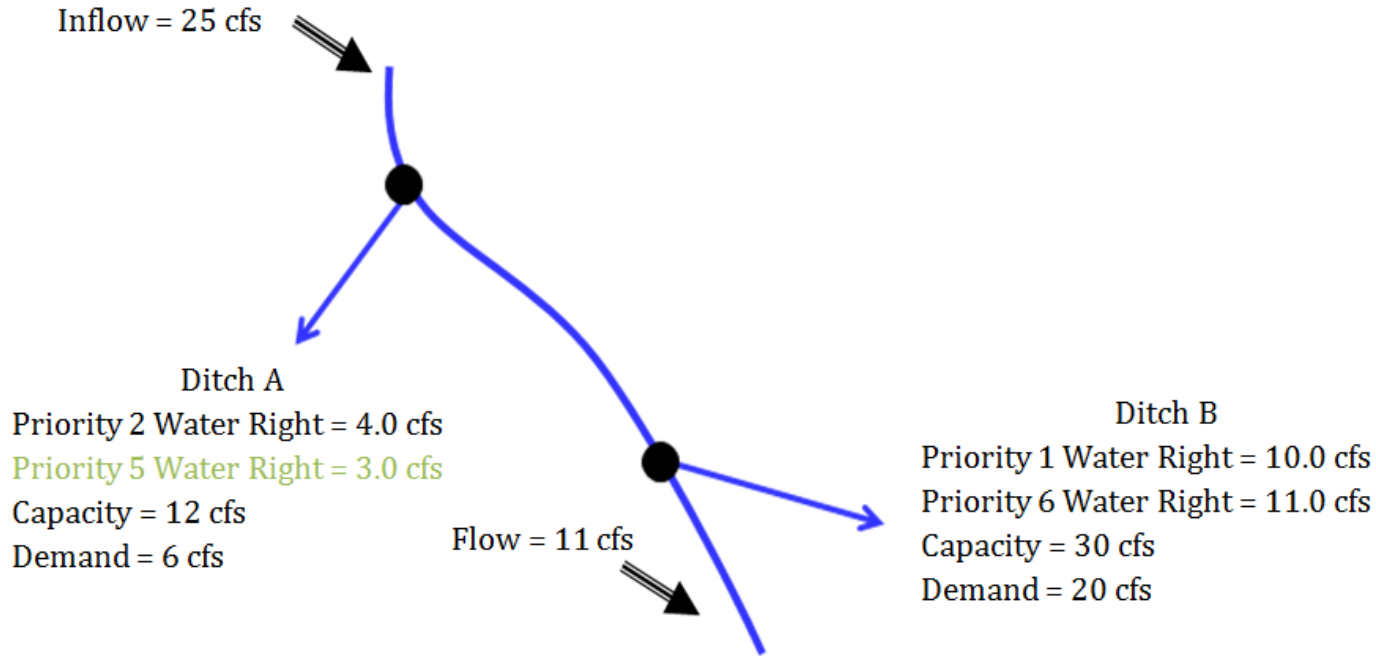
1) Priority 1: Diversion = min (demand, water right, capacity, available flow) = min(20, 10, 30, 25) = 10 cfs
2) Demand decreased to 20 – 10 = 10 cfs
3) Diversion structure capacity decreased to 30 – 10 = 20 cfs
4) Available flow decreased to 25 – 10 = 15 cfs

StateMod Simulation, Step 2



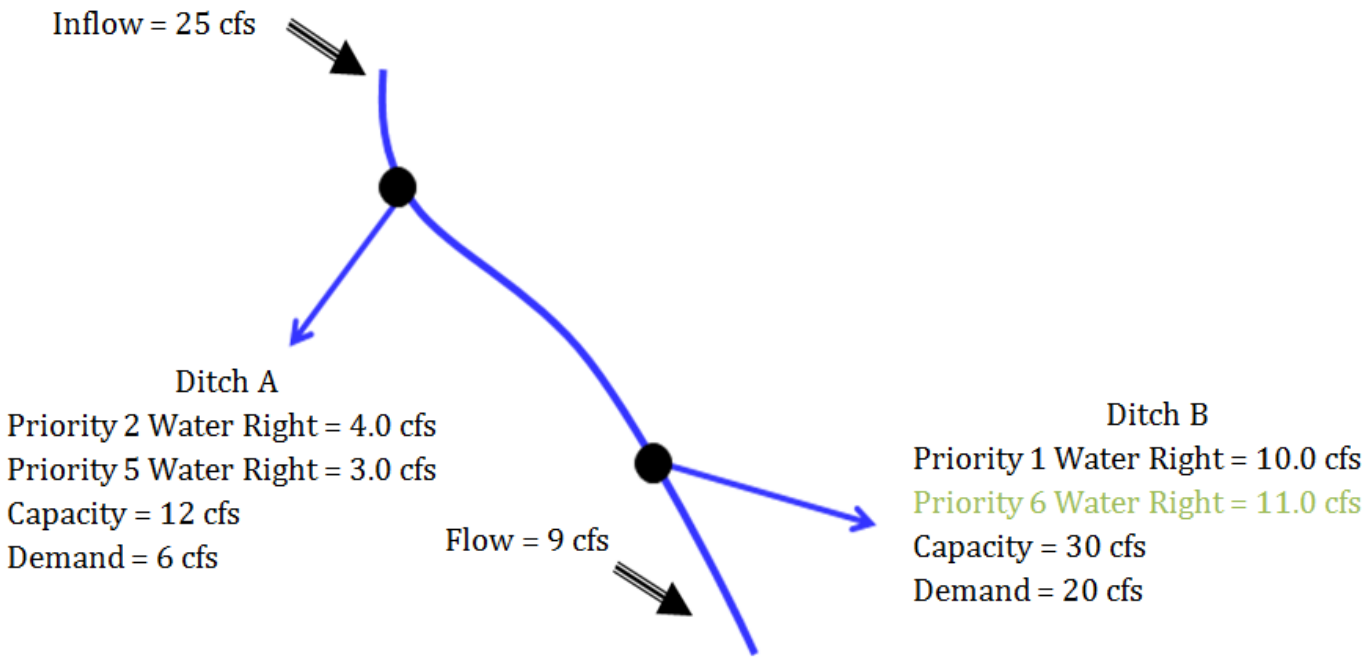
5) Priority 2: Diversion = min (demand, water right, capacity, available flow) = min(6, 4, 12, 15) = 4 cfs
6) Demand decreased to 6 – 4 = 2 cfs
7) Diversion structure capacity decreased to 12 – 4 = 8 cfs
8) Available flow decreased to 15 – 4 = 11 cfs

StateMod Simulation, Step 3



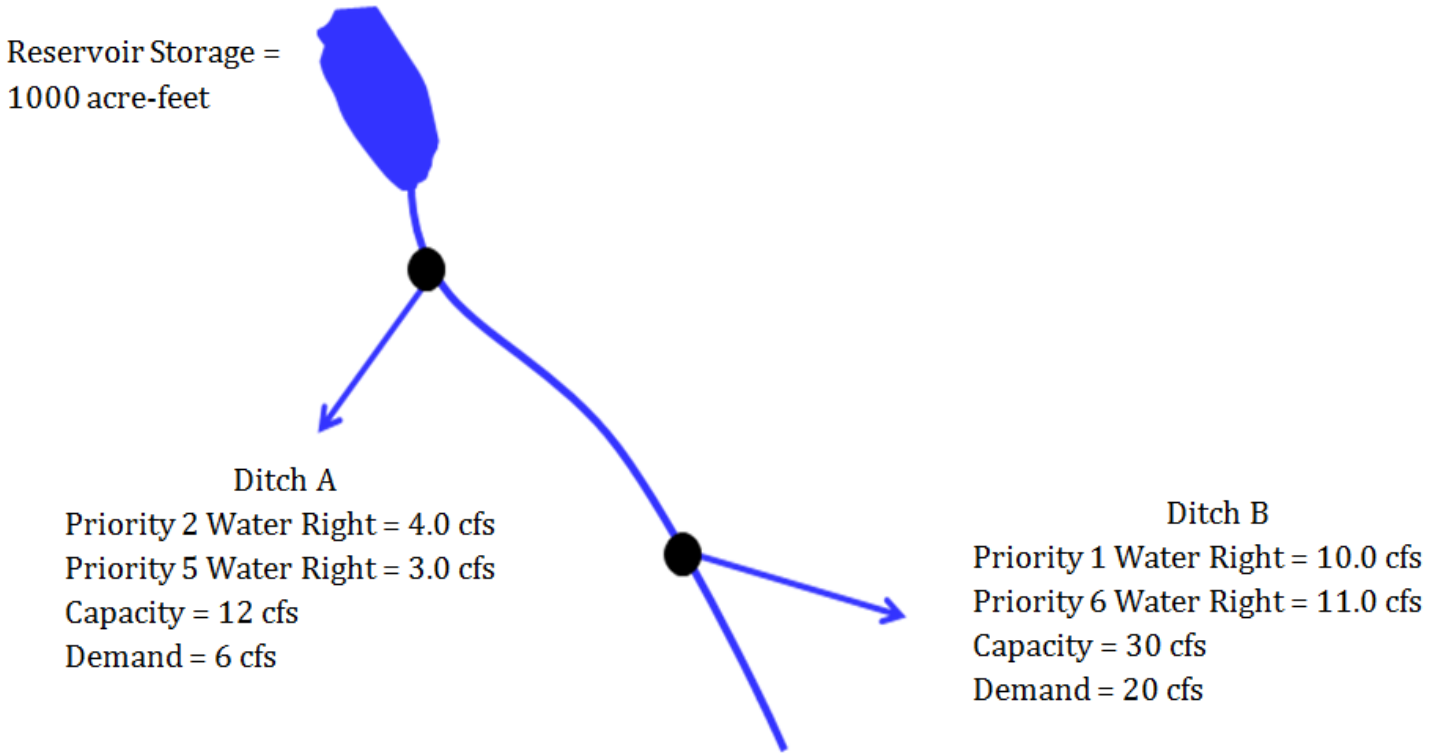
9) Priority 5: Diversion = min (demand, water right, capacity, available flow) = min(2, 3, 8, 11) = 2 cfs
10) Demand decreased to 2 – 2 = 0 cfs Demand is Satisfied
11) Available flow decreased to 11 – 2 = 9 cfs

StateMod Simulation, Step 4



12) Priority 6: Diversion = min (demand, water right, capacity, available flow) = min(10, 11, 20, 9) = 9 cfs
13) Diversion structure capacity decreased to 20 – 9 = 11 cfs
14) Demand decreased to 10 – 9 = 1 cfs Demand is Not Satisfied
15) Available flow decreased to 9 – 9 = 0 cfs

StateMod Simulation, Step 5

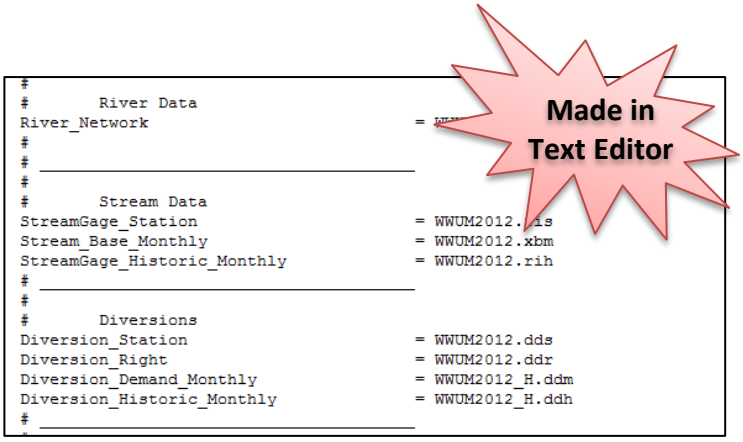


16) Priority 6.1: Reservoir Release = min (demand, capacity, reservoir storage) = min(1, 11, 1000) = 1 cfs
17) Diversion structure capacity decreased to 11 - 1 = 10 cfs
18) Demand decreased to 1 – 1 = 0 cfs Demand is Satisfied

Control & Network File Development

Response File (*.rsp)

- Lists the files to be included in the analysis.
- Only include files necessary for the analysis.
- Output files adopt the name of the response file, use unique response file names to track scenarios.




```
#
#       River Data
River_Network                          = WW
#
# ____________________________________
#
#       Stream Data
StreamGage_Station                     = WWUM2012.sta
Stream_Base_Monthly                    = WWUM2012.xbm
StreamGage_Historic_Monthly            = WWUM2012.rih
# ____________________________________
#
#       Diversions
Diversion_Station                      = WWUM2012.dds
Diversion_Right                        = WWUM2012.ddr
Diversion_Demand_Monthly               = WWUM2012_H.ddm
Diversion_Historic_Monthly             = WWUM2012_H.ddh
# ____________________________________
```

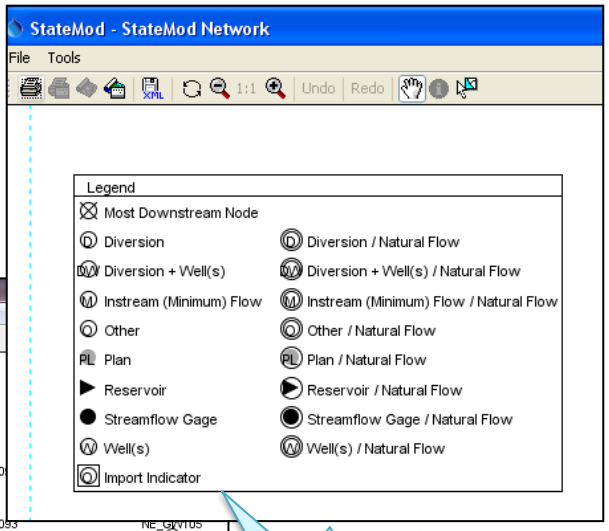
Control File (*.ctl)

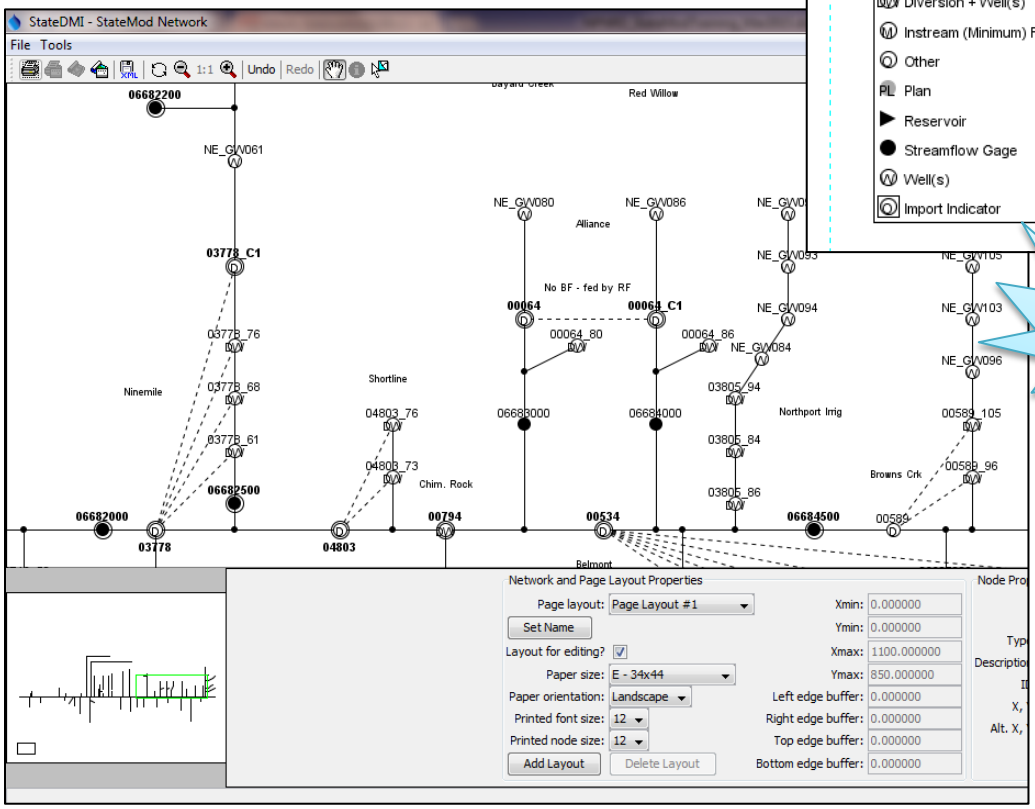
- Lists model control options.
- Includes comments, period of record, output options, use of well files, daily or monthly simulation.


```
Western Water Use Management Model(WWUM Model)
Historical Simulation
   1933     : iystr   STARTING YEAR OF SIMULATION
   2013     : iyend   ENDING YEAR OF SIMULATION
      2     : iresop  OUTPUT UNIT OPTION. 1 FOR [CFS], 2 FOR [AF], 3 FOR [KAF]
      0     : moneva  TYPE OF EVAP. DATA. 0 FOR VARIANT DATA. 1 FOR CONS. DATA
      2     : ipflo   TYPE OF STREAM INFLOW. 1 FOR TOTAL FLOW. 2 FOR GAINS
      0     : numpre  NO. OF PRECIPITATION STATIONS
      1     : numeva  NO. OF EVAPORATION STATIONS
     -1     : interv  NO. OF TIME INTERVALS IN DELAY TABLE. MAXIMUM=60.
 1.9835     : factor  FACTOR TO CONVERT CFS TO AC-FT/DAY (1.9835)
 1.9835     : rfacto  DIVISOR FOR STREAM FLOW DATA;    ENTER 0 FOR DATA IN cfs, ENTER 1.9835 FOR DATA IN af/mo
 1.9835     : dfacto  DIVISOR FOR DIVERSION DATA;      ENTER 0 FOR DATA IN cfs, ENTER 1.9835 FOR DATA IN af/mo
      0     : ffacto  DIVISOR FOR IN-STREAM FLOW DATA; ENTER 0 FOR DATA IN cfs, ENTER 1.9835 FOR DATA IN af/mo
 1.0        : cfacto  FACTOR TO CONVERT RESERVOIR CONTENT TO AC-FT
 1.0        : efacto  FACTOR TO CONVERT EVAPORATION DATA TO FEET
 1.0        : pfacto  FACTOR TO CONVERT PRECIPITATION DATA TO FEET
 CYR        : cyr1    Year type (a5, All caps, right justified !!)
      1     : icondem 1=no add; 2=add, 3=total demand in *.ddm
      0     : ichk    0 = off, 1=print river network,  -n= detailed printout at river node ichk
      0     : ireopx  Re-operation switch (0=re-operate;1=no re-operation)
      1     : ireach  Switch for instream flow reach approach (0=No insream flow reach approach, 1=Instream reach appr
      0     : icall   Switch for detailed call data (0=no detailed call data; 1=yes detailed call data)
      0     : ccall   Detailed call water right ID (not used if icall=0)
      0     : iday    Switch for daily calculations (0=monthly analysis; 1=daily analysis)
      1     : iwell   Switch for well operations (0=no wells in *.rsp;-1=no wells but in *.rsp;1=yes wells no max limi
      0     : gwmaxrc Constant maximum recharge limit (cfs); only used when iwell = 2
      0     : isjrip  Switch for an annual San Juan Recovery Program Sediment file
     10     : itsfile Switch for an annual time series file (-1=no *.tsp but in *.rsp,0=no tsfile,1=RGDSS GW acres ts
      1     : ieffmax Switch for irrigation water requirement (IRW) file
      0     : isprink Switch for sprinkler data (area and efficiency) use (0=off, 1=Maximum Supply, 2=Mutual Supply
      3     : soild   Switch for soil moisture accounting
```

Network File (*.net):

- Visual representation of the river network
- Not read by StateMod
- Defines structure types (e.g. wells, reservoirs, diversions)





Made in StateDMI

River Network File (*.rin)

- List of all structures, with upstream and downstream structures.
- Generated from the graphical Network File.
- Read by StateMod.

Made in StateDMI

```
#>  ID           cstaid:  Station ID
#>  Name         stanam:  Station name
#>  Downstream   cstadn:  Downstream node ID
#>  Comment     comment:  Alternate identifier/comment.
#>  GWMax        gwmaxr:  Max recharge limit (cfs) - see iwell in control file.
#>
#>    ID                Name          DownStream     Comment     GWMax
#>---------eb---------------------eb----------exb----------exb------e
06680700    Winters Creek at Tri-Sta01311_C2      06680700        -999
01311_C2    Enterprise_WintersCrkCar01311_207     01311_C2        -999
01311_207   EnterpriseCanal_URF207  05701_C1      01311_207       -999
05701_C1    WintersCreek_WintersCrkC05701_202     05701_C1        -999
05701_202   WintersCreekCanal_URF20205701_201     05701_202       -999
05701_201   WintersCreekCanal_URF20105701_29      05701_201       -999
05701_29    WintersCreekCanal_URF29 06681000      05701_29        -999
06681000    Winters Creek near Scott03563         06681000        -999
03563       MinatareCanal           00746         03563           -999
00746       CastleRockCanal         06682000      00746           -999
06682000    NPR near Minatare, NE   03778         06682000        -999
03778       NinemileCanal           04803         03778           -999
```

Streamflow Gage Input File Development

Streamflow Gage Station File (*.ris)

- List of streamflow gages and any un-gaged nodes with natural flow

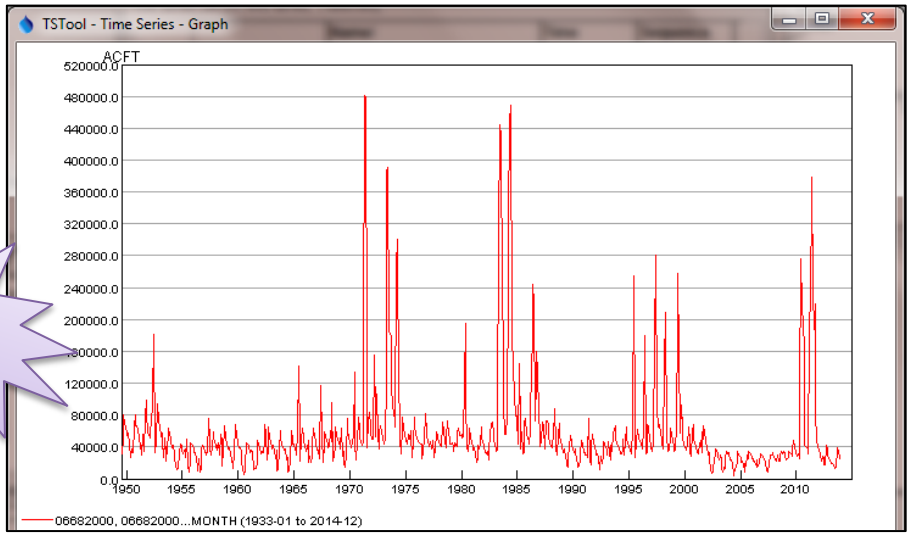
Made in StateDMI

```
#>  ID          crunid:  Station ID
#>  Name        runnam:  Station name
#>  River ID     cgoto:  River node with stream gage
#>  Daily ID   crunidy:  Daily stream station ID.
#>
#>    ID              Name           River ID     Daily ID
#>---------eb----------------------eb----------exb----------e
00064       AllianceCanal           00064        06684500
00064_C1    Alliance_RedWillowCarrie00064_C1     06684500
00283       BeerlineCanal           00283        06686000
00534       BelmontCanal            00534        06684500
00534_C1    Belmont_CedarCreek      00534_C1     06686000
00746       CastleRockCanal         00746        06682000
00754       CentralCanal            00754        06682000
00794       ChimneyRockCanal        00794        06684500
```

Streamflow Gage Historical Flow File (*.rih)

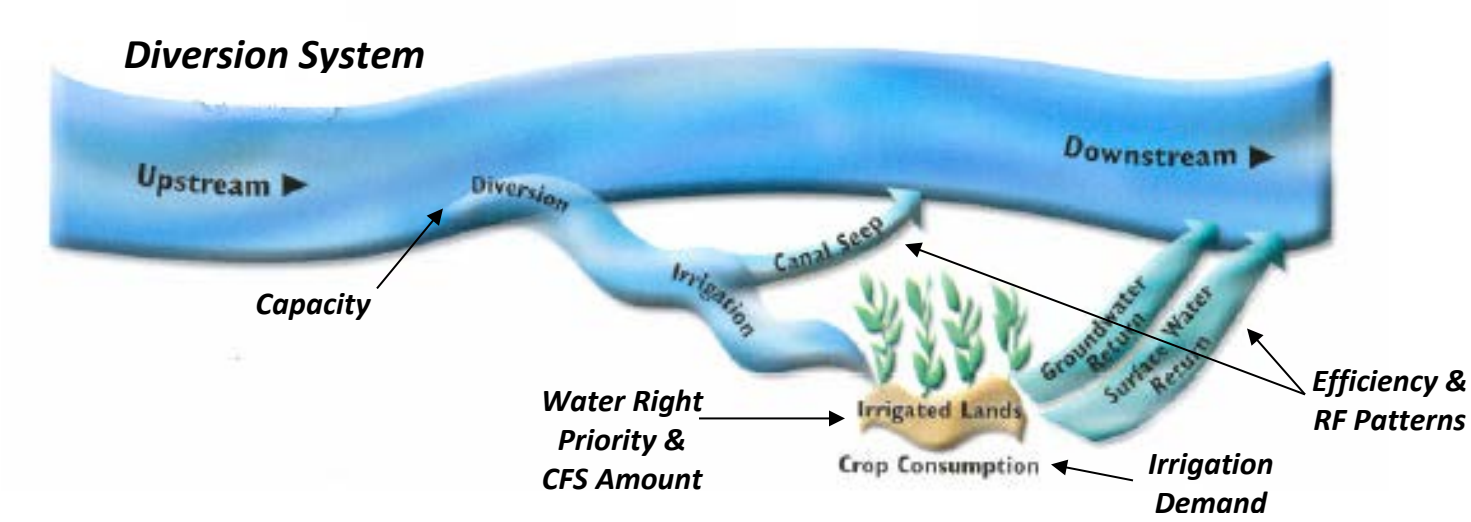
- Historical time series of streamflow records
- Used for calibration only, can have missing data.
- Developed from daily USGS and NDNR streamflow gage data.

Made in TSTool




```
#> Yr ID           Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep     Oct     Nov     Dec     Total
#>-e-b----------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb--------e
    1/1933  -     12/2014 ACFT  CYR
...
1962 06656000      106.   10365.  17598.  64166. 171454.  28364. 206324. 285803. 188194.   3416.   1092.     83.   976965.
1962 06657000       15.     344.   1157.   3931.  43581.  12809.  60812.  79697.  26273.   5046.   1729.    131.   235525.
1962 06670500     4774.    6236.   7329.   8529.   8541.  13291.  10534.   3892.   4435.   4681.   5028.   5260.    82530.
1962 06670900     -999.    -999.   -999.   -999.   -999.   -999.   -999.   -999.   -999.   -999.   -999.   -999.     -999.
1962 06671000      605.     688.    740.    913.   1761.   4334.    812.    609.   1615.   1573.   1059.    986.    15695.
1962 06672500      308.     372.    385.    317.   1533.   1295.   1648.   2640.   3223.    895.    641.    542.    13799.
1962 06673500      363.     360.    436.    349.   1147.   1323.   2670.   2709.   3527.    825.    554.    499.    14762.
1962 06674500    11141.   14087.  15818.  17330.  42947.  42528.  59255.  68875.  40636.  30933.  20797.  18804.   383151.
```

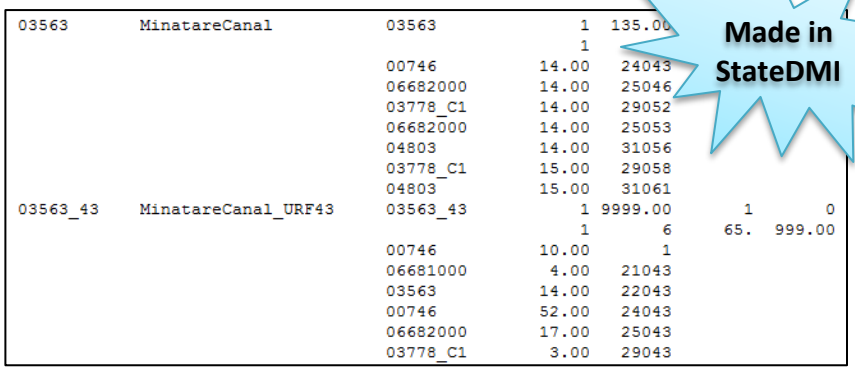
Diversion Structure Input File Development



DDS File	DDR File	DDH/DDM Files	DLY File
• Capacity • Return Flows • Efficiency	• CFS Amount • Priority	• Time Series of Historical or Baseline Demands	• Lag patterns for non-consumed water

Diversion Station File (*.dds)

- Lists all the physical information about diversion structures; including name, ID, capacity, efficiency and return flow patterns and locations.
- Operational capacities were based on sum of water rights or maximum sustained diversion.
- Return flow locations, generally read in from an external file (*.rtn).



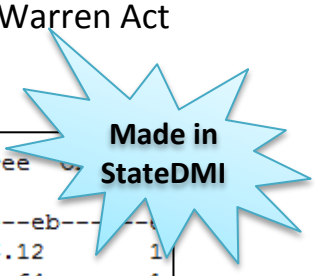
```
03563       MinatareCanal          03563              1  135.00
                                                      1
                                   00746          14.00   24043
                                   06682000       14.00   25046
                                   03778_C1       14.00   29052
                                   06682000       14.00   25053
                                   04803          14.00   31056
                                   03778_C1       15.00   29058
                                   04803          15.00   31061
03563_43    MinatareCanal_URF43    03563_43           1 9999.00       1       0
                                                      1       6   65.  999.00
                                   00746          10.00       1
                                   06681000        4.00   21043
                                   03563          14.00   22043
                                   00746          52.00   24043
                                   06682000       17.00   25043
                                   03778_C1        3.00   29043
```


WWUM Model Integration Point:

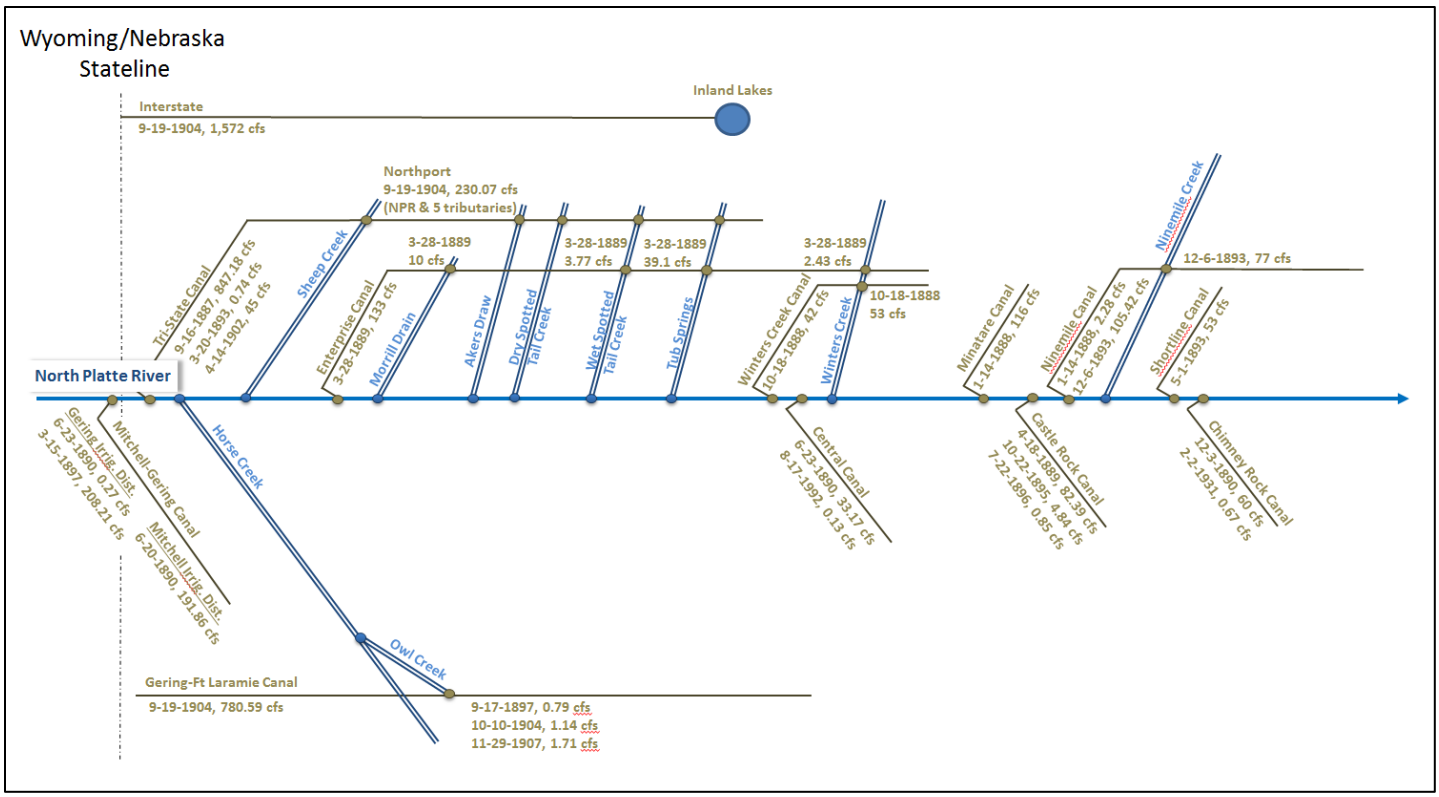
- The accretion return flow location file (*_SW.rtn) is a table used to set accretion locations and timing. This information was obtained from the WWUM GW Model and input directly into the StateMod model. This integration allows the SW model to accrete subsurface irrigation and canal recharge to the river at a similar location with similar timing as experienced by the GW Model. This file also contains a calibrated percentage of overland irrigation returns, which was integrated back in the WWUM GW Model.

Diversion Rights File (*.ddr)

- Lists direct flow water rights and associated CFS amounts
- Water right format designated by yyyy.mmdd
- “Store” water rights (*.50) reflect CFS amounts based on Glendo/Warren Act contract storage volumes; priority junior to direct rights.



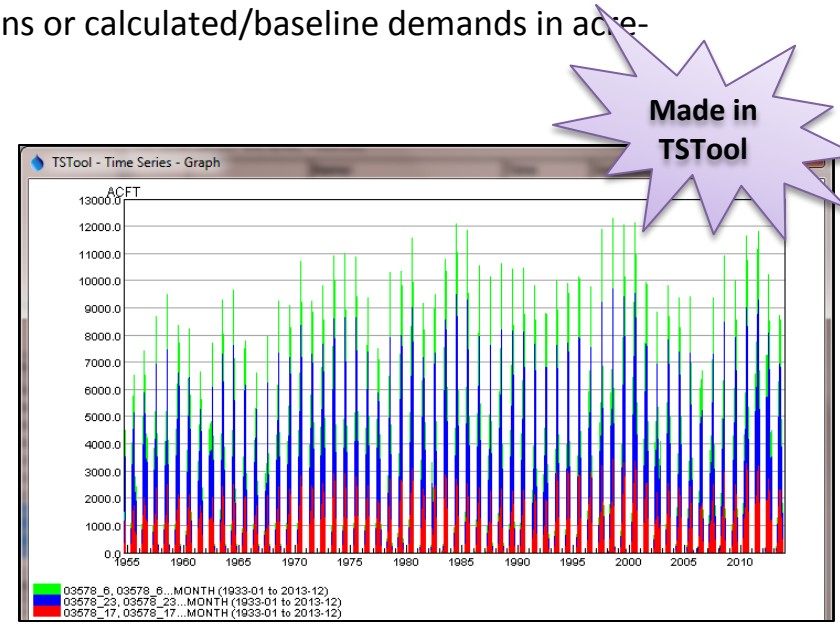

```
#>
#>   ID            Name              Struct          Admin #    Decree  O
#>EndHeader
#>---------eb----------------------eb----------eb--------------eb------eb-----
00064.01    Alliance Canal - Bayard 00064          1892.12260   36.12       1
00064.02    Alliance Canal - RedWil100064_C1       1892.12260   51.64       1
00064.03    Alliance Canal - RedWil100064_C1       1912.02280    2.00       1
00165.01    Burbank Ditch           00165          1891.11060    4.43       1
00165.02    Burbank Ditch           00165          1898.04120    0.71       1
00165.50    Burbank Ditch-Store     00165          1993.00030    3.30       1
00187.01    Torrington Canal        00187          1891.11280   34.51       1
00187.50    Torrington Canal-Store  00187          1993.00060   16.50       1
00283.01    Beerline Canal          00283          1894.10130   14.19       1
00283.50    Beerline Canal-Store    00283          1993.00160   27.00       1
```



See the WWUM Water Resources Model User's Manual for the complete water rights "straight line"

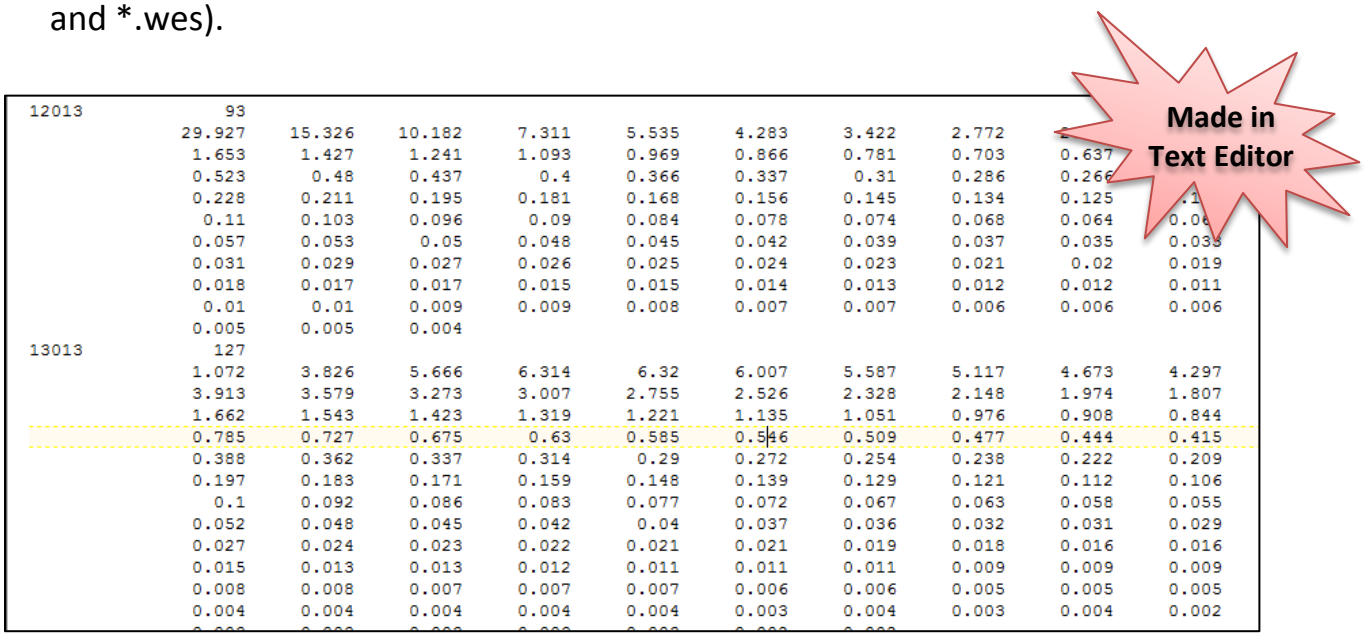
Historical Diversion File & Diversion Demand File (*.ddh &*.ddm)

- Time series of historical diversions or calculated/baseline demands in acre-feet.
- Total headgate diversions were distributed to each URF based on pro-rata NIR.
- Diversion structures with associated URF demands are operated as carriers and set to zero.



Delay File (*.dly)

- Patterns indicate the percentage of lagged accretions or depletions that impact a stream zone in each time step.
- Each pattern represents a specific stream zone/URF combination; the first two digits are the stream zone, the last three are the URF zone.
- Patterns developed through unit pumping simulations of the WWUM GW Model.
- Delay patterns and locations are assigned in the diversion station file (*.dds and *.wes).



12013	93									
	29.927	15.326	10.182	7.311	5.535	4.283	3.422	2.772	[illegible]	
	1.653	1.427	1.241	1.093	0.969	0.866	0.781	0.703	0.637	
	0.523	0.48	0.437	0.4	0.366	0.337	0.31	0.286	0.266	
	0.228	0.211	0.195	0.181	0.168	0.156	0.145	0.134	0.125	[illegible]
	0.11	0.103	0.096	0.09	0.084	0.078	0.074	0.068	0.064	[illegible]
	0.057	0.053	0.05	0.048	0.045	0.042	0.039	0.037	0.035	[illegible]
	0.031	0.029	0.027	0.026	0.025	0.024	0.023	0.021	0.02	0.019
	0.018	0.017	0.017	0.015	0.015	0.014	0.013	0.012	0.012	0.011
	0.01	0.01	0.009	0.009	0.008	0.007	0.007	0.006	0.006	0.006
	0.005	0.005	0.004							
13013	127									
	1.072	3.826	5.666	6.314	6.32	6.007	5.587	5.117	4.673	4.297
	3.913	3.579	3.273	3.007	2.755	2.526	2.328	2.148	1.974	1.807
	1.662	1.543	1.423	1.319	1.221	1.135	1.051	0.976	0.908	0.844
	0.785	0.727	0.675	0.63	0.585	0.546	0.509	0.477	0.444	0.415
	0.388	0.362	0.337	0.314	0.29	0.272	0.254	0.238	0.222	0.209
	0.197	0.183	0.171	0.159	0.148	0.139	0.129	0.121	0.112	0.106
	0.1	0.092	0.086	0.083	0.077	0.072	0.067	0.063	0.058	0.055
	0.052	0.048	0.045	0.042	0.04	0.037	0.036	0.032	0.031	0.029
	0.027	0.024	0.023	0.022	0.021	0.021	0.019	0.018	0.016	0.016
	0.015	0.013	0.013	0.012	0.011	0.011	0.011	0.009	0.009	0.009
	0.008	0.008	0.007	0.007	0.007	0.006	0.006	0.005	0.005	0.005
	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.003	0.004	0.002

WWUM Model Integration Point:

- Information in the Delay File (*.dly) was obtained from the WWUM GW Model and input directly into the StateMod model. This integration allows the SW model to accrete recharge and deplete pumping at a similar location and with similar timing as experienced by the GW Model.

Consumptive Use Input Files – StateCU Interaction

StateCU provides the following information to the StateMod model:

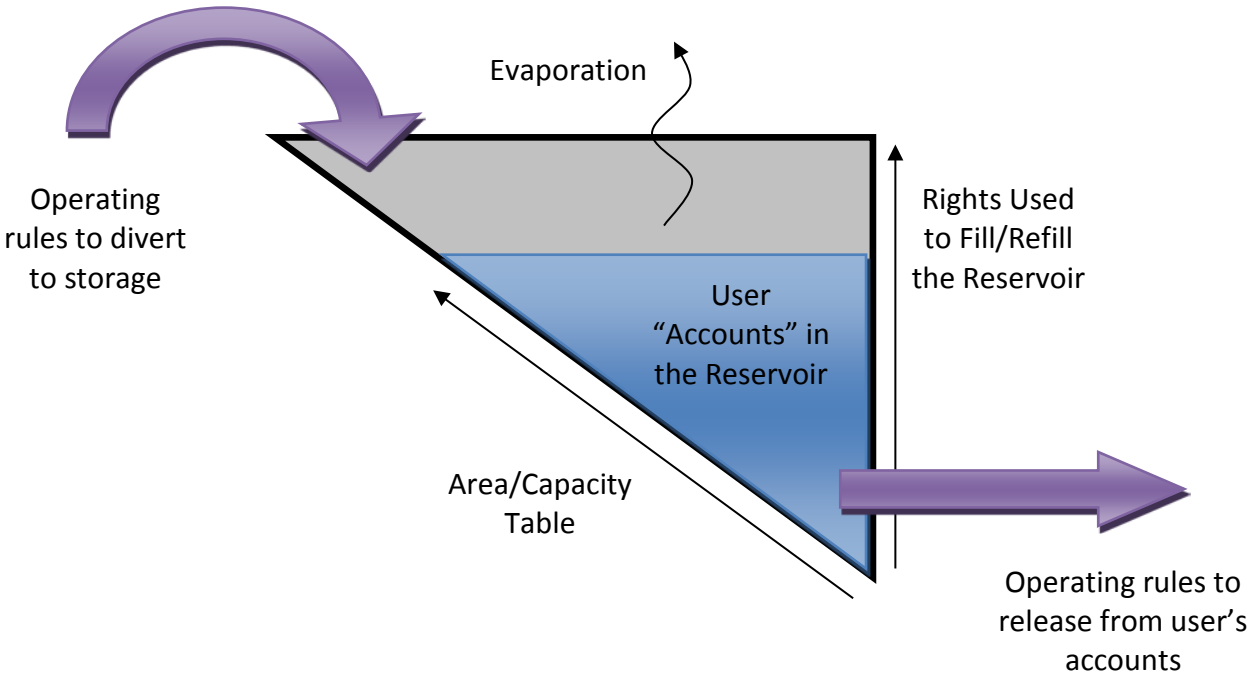
- Available water capacity information from the Structure File (*.str) for soil moisture volume.
- Conveyance and on-farm application efficiencies from the Irrigation Parameter File (*.ipy) for the on-farm water balance.
- Monthly irrigation water requirement from the Net Irrigation Requirement File (*.rcr, *.ddc) for the calculated demands.

Variable Efficiency Approach

Although efficiencies are used to calculate headgate demands based on crop irrigation requirements, there is not always enough water to meet full headgate demands. When ditches are "water short", irrigators generally are more efficient in their practices; therefore less water (as a percentage of diversion) returns to the river.

StateMod has the option to use the "variable efficiency" approach for agricultural demands. Diverted water is compared each time-step to CIR and efficiencies are allowed to vary up to a maximum defined by the user. CIR values are estimated using StateCU and read directly by StateMod.

Reservoir Input File Development



RES File	EVA File	RER File	EOM/TAM Files	OPR File
• Area/Capacity • Accounts • Evap. Pattern	• Net evap. rates	• Storage rights • 1st/2nd Fill	• Time Series of Historical or Baseline Contents	• Rules to fill and release

Reservoir Station File (*.res)

- Lists all the physical information about reservoirs; including name, ID, area/capacity table, evaporation pattern, accounts, initial and maximum volume.
- Inland Lakes aggregated together into one lake; operated as one.
- Reservoir accounts used to separate ownership in the reservoir; operating rules can tie water rights and releases to a specific account.

Made in StateDMI

```
#>
#>    ID              Name              Node      On/Off  RDate       Daily
#>---------eb--------------------eb----------eb------eb------exb-------e
#>                        VolMin  VolMax  FloMax  DeadSt NumOwner NumEva  NumPre  NumTab
#>xxxxxxxxxxxxxxxxxxxxxxb------eb------eb------eb------eb------eb------eb------e
#>                         OwnName   OwnMax   Sto-1 EvapTyp FillTyp
#>xxxxxxxxxxxxxxxxxxxxxxb----------eb------eb------eb------eb------e
#>                        Evap Id    EvapWt
#>xxxxxxxxxxxxxxxxxxxxxxb----------eb------e
#>                        Prec Id    PrecWt
#>xxxxxxxxxxxxxxxxxxxxxxb----------eb------e
#>                        Cont    Area    Seep
#>xxxxxxxxxxxxxxxxxxxxxxb------eb------eb------e
#>EndHeader
#>
InlandAg    Inland Lakes Agg Res    InlandAg          1     -1.
                                 0.  73640.    880.      0.       1       1       0       8
            Lowline_Irri  73640.  73640.       0       1
            Evaporation 10001          100.
            CAP-AREA  0     0.00    0.00       0
            CAP-AREA  1     7551.    750       0
            CAP-AREA  2     9468.   1250       0
            CAP-AREA  3    17655.   1750       0
            CAP-AREA  4    30869.   2250       0
            CAP-AREA  5    44737.   2750       0
            CAP-AREA  6    73640.   3521       0
            CAP-AREA  7   999999.   3600       0
```

Evaporation File (*.eva)

- Represents monthly net evaporation rates in feet, if gross evaporation is used, a precipitation file must also be created and included in the response file.
- Values based on average USBR evaporation on Inland Lakes.
- Can provide monthly time series or average annual.
- Define evaporation pattern in the reservoir station file (*.res).
- StateMod estimates the surface area of the reservoir each month based on an interpolation of the area/capacity table, and multiplies the surface area by the monthly rate to determine evaporation.

Made in Text Editor

```
# NA ID              Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep     Oct     b
# -e-b----------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------b
   01/   0  -     12/   0   FT  CYR
     10001        0.0495  0.067   0.127   0.244  0.3696   0.452   0.534   0.456   0.288   0.185   0.074   0.047
```

Reservoir Right File (*.rer)

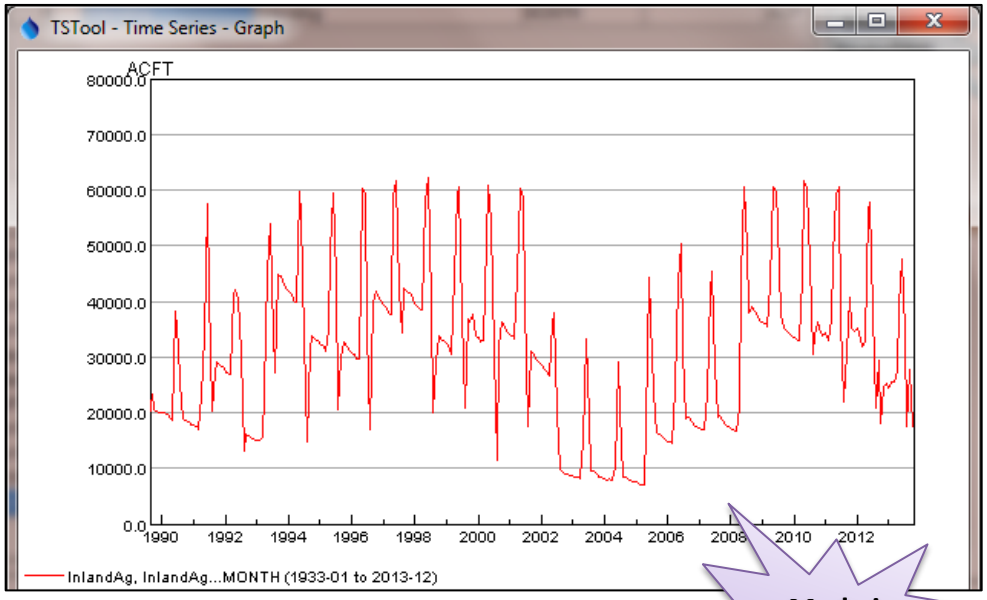
- Lists reservoir storage rights and associated acre-feet amounts
- Set accounts to receive water stored under a storage right.
- Water right format designated by yyyy.mmdd

```
#>
#>    ID      Name                    Res ID           Admin #    Decree  On/Off  Owner    Type     Fill #
#>---------eb----------------------eb----------eb--------------eb------eb------eb------eb------eb------eb-
#>
#>EndHeader
#>
Inland.01   Inland Lakes            InlandAg         1904.12061   73640       1       1       1       1
```

Made in StateDMI

Historical Reservoir Contents File & Reservoir Target File (*.eom &*.tar)

- Time series of historical end-of-month contents or capacity targets in acre-feet.
- Daily historical EOM contents available from USBR, aggregated to monthly.
- Historical contents used for historical calibration scenarios, targets (generally set to capacity) used in simulation scenarios.



Made in TSTool

```
#>
#> Yr ID           Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep     Oct     Nov     Dec     Total
#>-e-b----------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb------eb--------e
    1/1933  -     12/2013 ACFT  CYR
1933 InlandAg     15000.  15000.  15000.  15000.  15000.  15000.  15000.  15000.  15000.  15000.  15000.  15000.   180000.
1933 InlandAg     69000.  69000.  69000.  69000.  69000.  69000.  69000.  69000.  69000.  69000.  69000.  69000.   828000.
```

Additional Input Files

The input files above are those generally used to represent a majority of the dynamic operations in the river basin. There are additional input files associated with this model that follow the general file setup (i.e. files ending in "s" are structure files, files ending in "r" are rights files). The following should be noted about the development of these input file groups:

Instream Flow Files (*.ifs, *.ifr, *.ifa)

- Instream flows, or non-consumptive instream demands, were used to simulate the downstream call in the model.
- North Platte Irrigation Ditch, with an 1884 right of 201 cfs, was included as the downstream call.
- Additional instream flow structures can be implemented to simulate downstream demands for future scenarios.

Well Files (*.wes, *.wer, *.weh/*.wem)

- Structures with supplemental pumping and structures with ground water only demands are both included in the well files.
- Ground water only structures are designated with "NE_GW" followed by the URF zone.
- Well depletions are designated in the depletion location file (*_GW.rtn), which is similar to the accretion return flow location file discussed above.
- Well right file reflects each well in each URF, including its capacity, an on-date corresponding to the year the well first irrigated, and a senior priority.

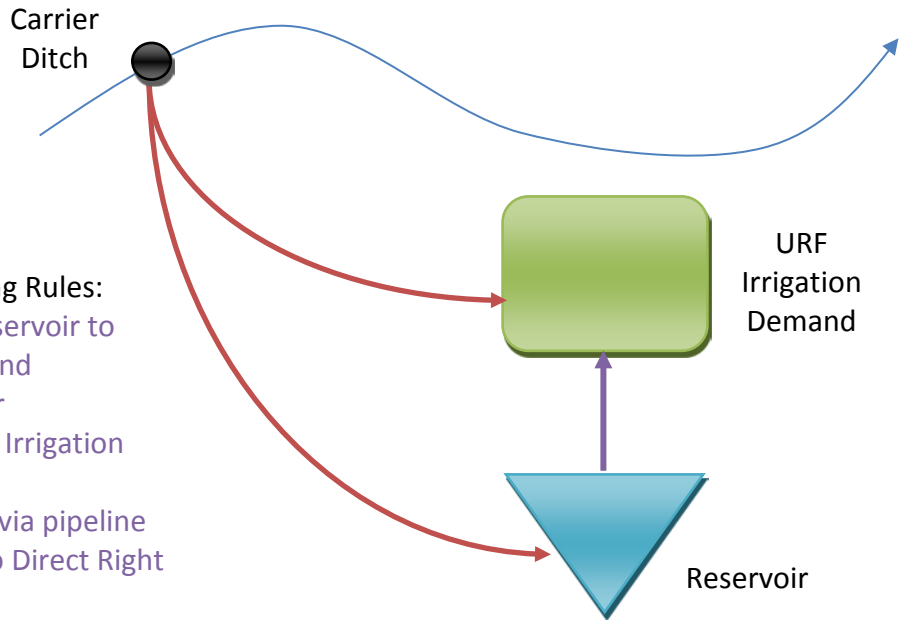
WWUM Model Integration Point:

- The depletion location file (*_GW.rtn) is a table used to set depletion locations and timing. This information was obtained from the WWUM GW Model and input directly into the StateMod model. This integration allows the SW model to deplete the river at a similar location with similar timing as experienced by the GW Model.
- Historical pumping is input into the SW model and reflects the calibrated pumping developed in the StateCU analysis. Metered pumping, as provided by the NPNRD, is aggregated by URF and input into the model reflecting the pumping demands for recent years.

See the StateMod Documentation and WWUM Water Resources Model User's Manual for more information on the format, content, and development of these files.

Operating Rules

Any operations in the model more complex than a direct right diversion or pumping to meet an irrigation demand must be simulated using operating rules. StateMod operating rules direct water to be diverted or transferred from a Source to a Destination with a particular Delivery Method.



River Diversion Rules:
Fill Reservoir via Carrier Ditch under the reservoir right.
Source: Reservoir Water Right
Carrier: Carrier Ditch
Destination: Reservoir
Rule No.: Type 11 or 45
Priority: Set to Reservoir Right

Divert for irrigation at URF Irrig. Demand via Carrier Ditch under direct right.
Source: Ditch Water Right
Carrier: 0400524
Destination: URF Irrigation Demand
Rule No.: Type 11 or 45
Priority: Set to Direct Right

Release Operating Rules:
Release from Reservoir to URF Irrig. Demand
Source: Reservoir
Destination: URF Irrigation Demand
Rule No.: Type 3 via pipeline
Priority: Junior to Direct Right

Operating Rules most commonly used in the WWUM SW Model:

- **Type 3** – a release from storage directly to a carrier (a ditch or canal as opposed to the river), for delivery to a demand structure. Typically, the reservoir supply is supplemental, and its release is given an administration number junior to direct flow rights at the destination structure. A release is made only if demand at the demand structure is not satisfied after direct flow rights have diverted. In the WWUM Model, the Type 3 operating rule is used to release water from the Inland Lakes reservoir system to the Pathfinder Irrigation District demands downstream of the reservoirs.

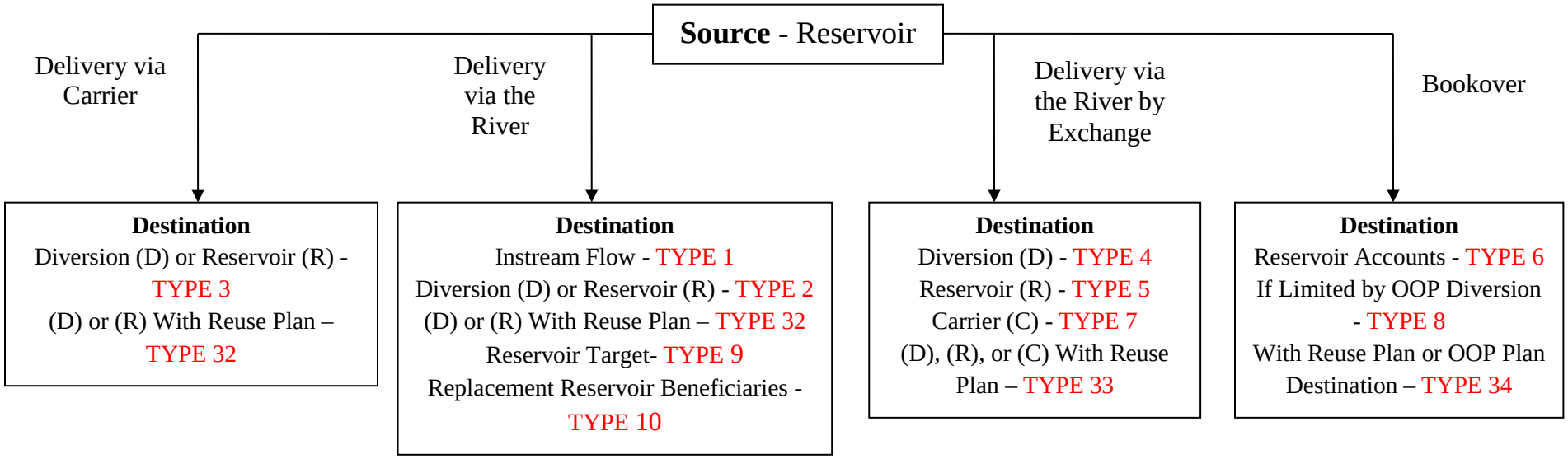
- **Type 11** – a direct flow diversion to demand structure or reservoir through an intervening carrier. It uses the administration number and decreed amount of the direct flow right associated with the carrier, regardless of the administration number assigned to the operating right itself. In the WWUM Model, the Type 11 operating right is used to carrier a direct flow diversion to a URF-based demand structures.

- **Type 45** – Type 45 operates the same as Type 11, allowing a direct flow diversion to demand structure or reservoir through an intervening carrier, however it allows the carrier loss (e.g. "Carriage Loss Agreement") to be defined in the operating rule. It uses the administration number and decreed amount of the direct flow right associated with the carrier, regardless of the administration number assigned to the operating right itself. In the WWUM Model, the Type 45 operating right is used both as a direct flow diversion to URF-based demand structures, and as a direct flow diversion to the Inland Lakes reservoir system.

- Many variables and flags are available for each operating rule depending on the operating rule type. Refer to Section 4.13 in the StateMod Documentation for discussion on the operating rule variables.
- Use Decision Trees from the StateMod Documentation to assist with operating rule selection and understanding.

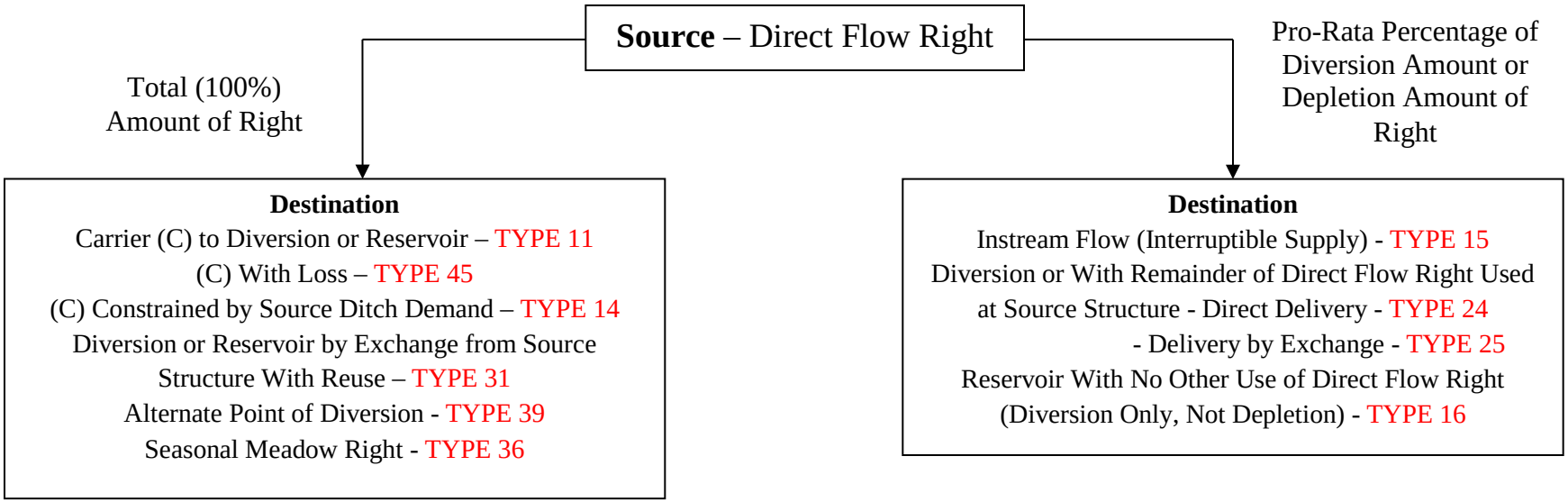
STATEMOD OPERATING RULES DECISION TREE

Operating Rule Types Based on Source Reservoir



STATEMOD OPERATING RULES DECISION TREE

Operating Rule Types Based on Source Direct Flow Right



Inflow Hydrology

StateMod operates based on Natural Flows (a.k.a. Baseflows), which ideally would flow in the river before man's influence. The WWUM Model begins at Whalen Dam in Wyoming; therefore Natural Flow for this model is a combination of historical gaged inflows and natural flow "gains" based on precipitation recharge.

- **Historical streamflow gage records** were used as Natural Flows for major tributaries on the river (i.e. not drains or tributaries with flow generated primarily from return flows.
    - North Platte River below Guernsey Reservoir, WY
    - Laramie River, WY
    - Rawhide Creek, WY
    - Pumpkin Creek, NE

- **Overland inflows** were estimated by CropSim as the portion of the historical precipitation that is not recharged and reaches rivers and tributaries via surface runoff.

- **Subsurface inflows** were estimated using the WWUM GW Model, whereby precipitation recharge is lagged back to rivers and tributaries and enters the model as natural flow "gains".

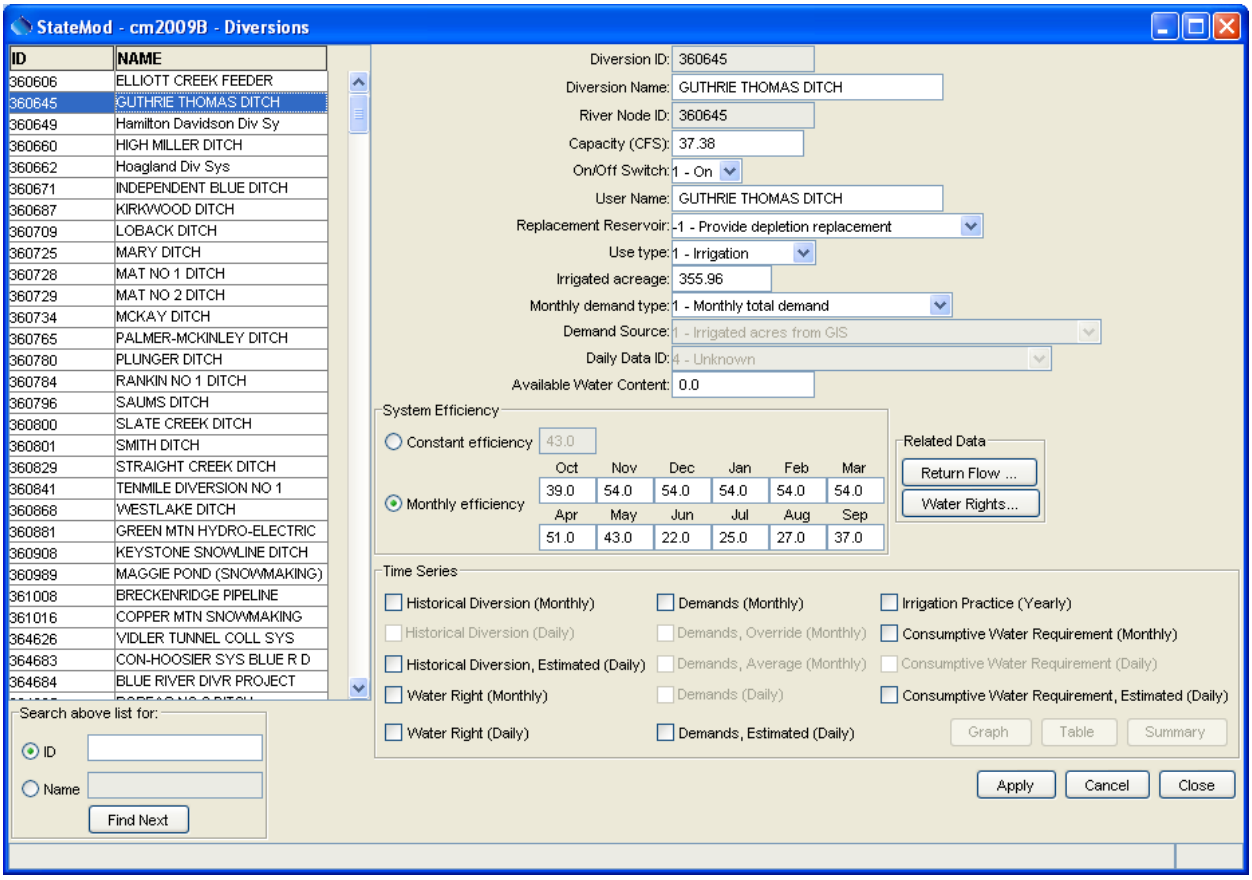
The time series of these Natural Flows formatted using TSTool and input into the model using the Natural Flow Data File (*.xbm)

WWUM Model Integration Point:

- Natural Inflows are usually generated within the StateMod program; instead, this information was developed using WWUM Model applications and input directly into the StateMod Model.

Running StateMod

StateMod is a FORTRAN based executable with a separate graphical user interface (GUI) that can be used to view and edit input files. An existing StateMod scenario must exist for use with the GUI; the GUI cannot be used to create a new scenario "from scratch". Viewing existing model information through the GUI can be helpful, as information from several files can be viewed from single screen.

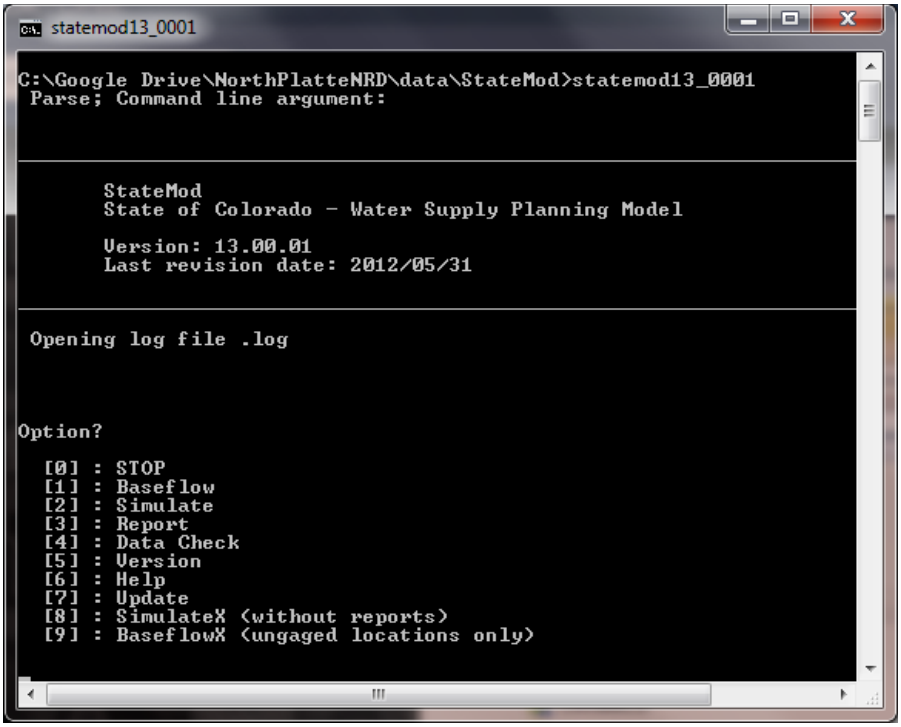


Note that edits made through the GUI remove the data-centered "transparency" inherent in the use of command files to create model input. Changes made to model inputs through the StateMod GUI are not "stamped" in the header of the associated input files. Therefore if command files are later used to update the model input, for example to extend the study period, revisions made through the GUI will not be reflected.

The StateMod Executable, GUI, and Documentation are available for download from the Colorado Decision Support System website (cdss.state.co.us)

Tip: Changes made through the StateMod GUI should be tracked and documented. As the changes are determined to be appropriate and "permanent", the command files should be revised to reflect the revisions.

The StateMod executable can be run through the StateMod GUI which will automatically enable an MS-DOS command window. If the GUI is not used, the user will need to open an MS-DOS window and navigate to the StateMod subdirectory where the scenario input files are saved. The StateMod executable should be saved to that subdirectory.



In the DOS Window, Type "StateMod *scenario name*" where the scenario name is defined by the name of the response file (*.rsp). The Scenario Name tells the model to read the input files listed in the *.rsp file. Once the scenario is loaded, the following options are available:

Data Check Mode

Enter "4" to perform a Data Check of the model input files. StateMod will run through the input files making sure they are complete and without errors. If successful, review the Check File (*.chk). If unsuccessful, review errors shown in the Log File (*.log). The following output files are provided by the Data Check option. These files, the Check File, and the Log File are written to the StateMod subdirectory that contains the *.rsp file.

- Natural Flow File (*.xcb)
- Direct Demand File (*.xcd)
- Instream Demand File (*.xci)
- Well Demand File (*.xcw)
- Input Summary File (*.xtb)
- Water Rights List File
- Log File (*.log)
- Check File (*.chk)

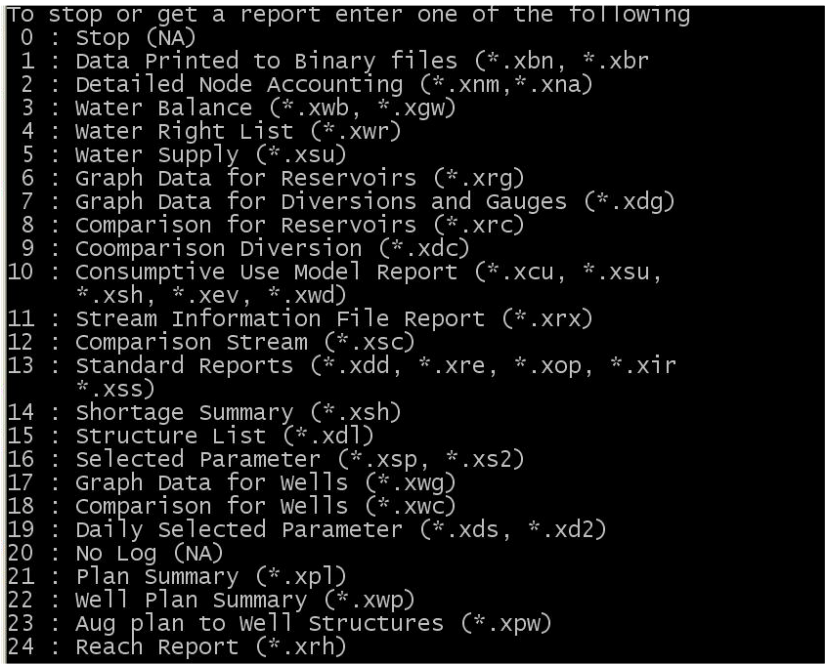
Note that all the output files associated with the Data Check options will have the same prefix as the response file. Section 5 of the StateMod Documentation provides information on all of the output files produced by Data Check and other Modeling Options.

Tip: Document any issues identified in the input files, and modify command files as necessary to address errors. Note that following the command-driven process where input files "build" on each other is the best way to minimize issues. Note that warnings do not necessarily indicate serious issues, but should be reviewed and documented. For example, a warning will be generated if a return flow location for a structure is to a different tributary.

Simulation

Enter "2" to perform a Simulation of the model. StateMod will show the progress of the simulation in the DOS window. Option 3 automatically creates standard output reports discussed in the next section. To simulate without reports, option 8 can be selected.

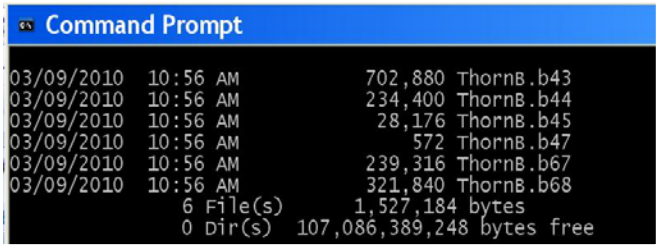
The model simulation will end with a "Successful Termination" message. Be sure to review the *.log file for warnings and errors identified during the simulation. Additional reports are available by selecting option 3, as discussed in Section 5 of the StateMod Documentation and shown.



StateMod Model Output Files

Several output files are available from StateMod, as summarized in Section 5 in the StateMod Documentation.

Binary Files (*.b*) are more compact in size and accessed by TSTool to review output data. Information (columns) summarized in output are individually available for each structure in the model. Binary files allow for ease of comparison, graphing and export capabilities.



Standard Output Reports:

- Diversion Output File (*.xdd) describes diversion and streamflow data at all river nodes. The report summarizes the structure demand, supply (from the river, carrier, storage, etc.), shortages, non-consumed returns and a hydrologic station balance of the inflow and outflow of the river at the structure location for each month of the study period. Available Flow (Column 29) represents the amount of physical flow at the node location that is available for diversion by a junior water right after all of the other model priorities have been simulated.
- Reservoir Output File (*.xre) describes diversion, release, storage and streamflow data at reservoir nodes. The report summarizes the reservoir contents, supply (from the river or carrier), releases, evaporation, seepage, and a hydrologic station balance of the inflow and outflow of the river at the reservoir location for each month of the study period.
- Operating Rule Information File (*.xop) describes the activity associated with each operating rule. The report is a tabular summary of the amount of water simulated by each operating rule and summarizes the operating rule parameters. TSTool has been recently enhanced to read the Operating Rule Information File output, similar to accessing the binary file information.

Diversion Output File (*.xdd)

TextPad - C:\Google Drive\NorthPlatteNRD\data\StateMod\wwum2012.xdd *

File Edit Search View Tools Macros Configure Window Help

wwum2012.xdd * | WWUM2012_SW.ipy | WWUM2012.rsp | WWUM2012.opr

Historical Simulation PAGE NO. 103

STRUCTURE ID (0 = total) : 03966_84 107
STRUCTURE ACCT (0 = total): 0
STRUCTURE NAME : Interstate_NE_PID_URF84
RIVER LOCATION - FROM : 03966_84 Interstate_NE_PID_URF84
RIVER LOCATION - TO : 03966_84 Interstate_NE_PID_URF84

				Demand		From River By					From Carrier By			Carried			Shortage		Water Use				Station In/Out					
Structure ID	River ID	Year	Mo	Total NA (1)	CU NA (2)	Priority (+) (3)	Storage (+) (4)	Other (+) (5)	Loss (-) (6)	From Well (+) (7)	Priority (+) (8)	Other (+) (9)	Loss (-) (10)	Exchang Bypass (+) (11)	From SoilM NA (12)	Total Supply NA (13)	Total Short NA (14)	CU Short NA (15)	CU NA (16)	To SoilM NA (17)	To Other NA (18)	Loss NA (19)	Upstrm Inflow (+) (20)	Reach Gain (+) (21)	Return Flow (+) (22)	Well Deplete (-) (23)	From/To GW Stor (+) (24)	River Inflow (+) (25)
03966_84	03966_84	1995	JAN	69.	0.	0.	0.	0.	0.	0.	0.	69.	0.	0.	0.	69.	0.	0.	0.	0.	69.	0.	921.	0.	0.	0.	0.	921.
03966_84	03966_84	1995	FEB	21.	0.	0.	0.	0.	0.	0.	21.	0.	0.	0.	0.	21.	0.	0.	0.	0.	21.	0.	778.	0.	0.	0.	0.	778.
03966_84	03966_84	1995	MAR	136.	0.	0.	0.	0.	0.	0.	0.	136.	0.	0.	0.	136.	0.	0.	0.	0.	136.	0.	740.	0.	0.	0.	0.	740.
03966_84	03966_84	1995	APR	2.	23.	0.	0.	0.	0.	0.	2.	0.	0.	0.	22.	25.	0.	0.	23.	0.	2.	0.	656.	0.	0.	0.	0.	656.
03966_84	03966_84	1995	MAY	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.	7.	0.	0.	7.	0.	0.	0.	679.	0.	0.	0.	0.	679.
03966_84	03966_84	1995	JUN	0.	36.	0.	0.	0.	0.	0.	0.	0.	0.	0.	36.	36.	0.	0.	36.	0.	0.	0.	580.	0.	0.	0.	0.	580.
03966_84	03966_84	1995	JUL	5256.	1346.	0.	0.	0.	0.	0.	0.	5256.	0.	0.	0.	5256.	0.	0.	1346.	65.	3843.	2.	2669.	0.	0.	0.	0.	2669.
03966_84	03966_84	1995	AUG	7209.	2079.	0.	0.	0.	0.	0.	0.	7209.	0.	0.	0.	7209.	0.	0.	2079.	0.	5127.	3.	3053.	0.	0.	0.	0.	3053.
03966_84	03966_84	1995	SEP	2038.	442.	0.	0.	0.	0.	0.	2038.	0.	0.	0.	0.	2038.	0.	0.	442.	0.	1595.	1.	2262.	0.	0.	0.	0.	2262.
03966_84	03966_84	1995	OCT	0.	10.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.	10.	0.	0.	10.	0.	0.	0.	1388.	0.	0.	0.	0.	1388.
03966_84	03966_84	1995	NOV	117.	0.	0.	0.	0.	0.	0.	0.	117.	0.	0.	0.	117.	0.	0.	0.	10.	107.	0.	1180.	0.	0.	0.	0.	1180.
03966_84	03966_84	1995	DEC	105.	0.	0.	0.	0.	0.	0.	0.	105.	0.	0.	0.	105.	0.	0.	0.	0.	105.	0.	1005.	0.	0.	0.	0.	1005.
03966_84	03966_84	1995	TOT	14952.	3943.	0.	0.	0.	0.	0.	2061.	12892.	0.	0.	75.	15027.	0.	0.	3943.	75.	11003.	6.	15913.	0.	0.	0.	0.	15913.

				Demand		From River By					From Carrier By			Carried			Shortage		Water Use				Station In/Out					
Structure ID	River ID	Year	Mo	Total NA (1)	CU NA (2)	Priority (+) (3)	Storage (+) (4)	Other (+) (5)	Loss (-) (6)	From Well (+) (7)	Priority (+) (8)	Other (+) (9)	Loss (-) (10)	Exchang Bypass (+) (11)	From SoilM NA (12)	Total Supply NA (13)	Total Short NA (14)	CU Short NA (15)	CU NA (16)	To SoilM NA (17)	To Other NA (18)	Loss NA (19)	Upstrm Inflow (+) (20)	Reach Gain (+) (21)	Return Flow (+) (22)	Well Deplete (-) (23)	From/To GW Stor (+) (24)	River Inflow (+) (25)
03966_84	03966_84	1996	JAN	71.	0.	0.	0.	0.	0.	0.	0.	71.	0.	0.	0.	71.	0.	0.	0.	21.	49.	0.	854.	0.	0.	0.	0.	854.
03966_84	03966_84	1996	FEB	25.	0.	0.	0.	0.	0.	0.	25.	0.	0.	0.	0.	25.	0.	0.	0.	7.	17.	0.	730.	0.	0.	0.	0.	730.
03966_84	03966_84	1996	MAR	93.	0.	0.	0.	0.	0.	0.	0.	93.	0.	0.	0.	93.	0.	0.	0.	0.	92.	0.	663.	0.	0.	0.	0.	663.
03966_84	03966_84	1996	APR	0.	174.	0.	0.	0.	0.	0.	0.	0.	0.	0.	174.	174.	0.	0.	174.	0.	0.	0.	776.	0.	0.	0.	0.	776.
03966_84	03966_84	1996	MAY	86.	160.	0.	0.	0.	0.	0.	86.	0.	0.	0.	134.	220.	0.	0.	160.	0.	60.	0.	667.	0.	0.	0.	0.	667.
03966_84	03966_84	1996	JUN	998.	396.	0.	0.	0.	0.	0.	998.	0.	0.	0.	96.	1094.	0.	0.	396.	0.	697.	0.	967.	0.	0.	0.	0.	967.
03966_84	03966_84	1996	JUL	7911.	1641.	0.	0.	0.	0.	0.	0.	7911.	0.	0.	0.	7911.	0.	0.	1641.	404.	5863.	3.	3697.	0.	0.	0.	0.	3697.
03966_84	03966_84	1996	AUG	6677.	1183.	0.	0.	0.	0.	0.	0.	6677.	0.	0.	0.	6677.	0.	0.	1183.	0.	5491.	3.	3537.	0.	0.	0.	0.	3537.
03966_84	03966_84	1996	SEP	1069.	33.	0.	0.	0.	0.	0.	1069.	0.	0.	0.	0.	1069.	0.	0.	33.	0.	1035.	1.	2244.	0.	0.	0.	0.	2244.
03966_84	03966_84	1996	OCT	0.	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.	0.	0.	3.	0.	0.	0.	1500.	0.	0.	0.	0.	1500.
03966_84	03966_84	1996	NOV	112.	0.	0.	0.	0.	0.	0.	0.	112.	0.	0.	0.	112.	0.	0.	0.	3.	108.	0.	1284.	0.	0.	0.	0.	1284.
03966_84	03966_84	1996	DEC	145.	0.	0.	0.	0.	0.	0.	0.	145.	0.	0.	0.	145.	0.	0.	0.	0.	145.	0.	1113.	0.	0.	0.	0.	1113.
03966_84	03966_84	1996	TOT	17186.	3590.	0.	0.	0.	0.	0.	2178.	15008.	0.	0.	407.	17593.	0.	0.	3590.	436.	13560.	7.	18032.	0.	0.	0.	0.	18032.

Shortage Water Use Station In/Out

Reservoir Output File (*.xre)

TextPad - C:\Google Drive\NorthPlatteNRD\data\StateMod\wwum2012.xre *

File Edit Search View Tools Macros Configure Window Help

wwum2012.xre * | wwum2012.xdd | WWUM2012_SW.ipy | WWUM2012.rsp | WWUM2012.opr

```
RESERVOIR ID              : InlandAg
RESERVOIR NAME            : Inland Lakes Agg Res
RESERVOIR ACCOUNT & AMOUNT:  0   73640.; where account 0 is the total
RESERVOIR OWNER           : Total
RIVER LOCATION            : Inland Lakes


STRUCTURE DATA            :     #        af

  Capacity                :     1    73640.
  Reservoir Rights        :     1    73640.
```

Reservoir ID	Acc	Year	Mo	Initial Storage NA (1)	From River by Priorty (+) (2)	Storage (+) (3)	Other (+) (4)	Loss (-) (5)	From Carrier by Priorty (+) (6)	Other (+) (7)	Loss (-) (8)	Total Supply NA (9)	From Storage to River For Use (-) (10)	River For Exc (-) (11)	Carrier for Use (-) (12)	Total Release NA (13)	Evap (-) (14)	Seep & Spill (-) (15)	EOM Content NA (16)	Targt_0 Stor_n Limit NA (17)	BOM Decree Limit NA (18)	Station Balance River Inflow (+) (19)	River Release (+) (20)	River Divert (-) (21)	River by Well (-) (22)	River Outflow NA (23)
InlandAg	0	1995	JAN	42369.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	453.	453.	131.	0.	41784.	69000.	31271.	921.	0.	0.	0.	921.
InlandAg	0	1995	FEB	41784.	0.	0.	0.	0.	206.	0.	0.	206.	0.	0.	0.	0.	177.	0.	41812.	69000.	31856.	778.	0.	0.	0.	778.
InlandAg	0	1995	MAR	41812.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1153.	1153.	333.	0.	40327.	69000.	31828.	740.	0.	0.	0.	740.
InlandAg	0	1995	APR	40327.	0.	0.	0.	0.	8996.	0.	0.	8996.	0.	0.	0.	0.	667.	0.	48656.	69000.	33313.	656.	0.	0.	0.	656.
InlandAg	0	1995	MAY	48656.	0.	0.	0.	0.	20344.	0.	0.	20344.	0.	0.	0.	0.	1155.	0.	67845.	69000.	24984.	679.	0.	0.	0.	679.
InlandAg	0	1995	JUN	67845.	0.	0.	0.	0.	1155.	0.	0.	1155.	0.	0.	0.	0.	1529.	0.	67471.	69000.	5795.	581.	0.	0.	1.	580.
InlandAg	0	1995	JUL	67471.	0.	0.	0.	0.	3699.	0.	0.	3699.	0.	0.	18641.	18641.	1686.	0.	50843.	69000.	6169.	2689.	0.	0.	19.	2669.
InlandAg	0	1995	AUG	50843.	0.	0.	0.	0.	6604.	0.	0.	6604.	0.	0.	42447.	42447.	1026.	0.	13974.	69000.	22797.	3090.	0.	0.	37.	3053.
InlandAg	0	1995	SEP	13974.	0.	0.	0.	0.	12284.	0.	0.	12284.	0.	0.	0.	0.	519.	0.	25740.	69000.	59666.	2272.	0.	0.	10.	2262.
InlandAg	0	1995	OCT	25740.	0.	0.	0.	0.	8690.	0.	0.	8690.	0.	0.	0.	0.	410.	0.	34019.	69000.	47900.	1388.	0.	0.	0.	1388.
InlandAg	0	1995	NOV	34019.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1234.	1234.	173.	0.	32612.	69000.	39621.	1180.	0.	0.	0.	1180.
InlandAg	0	1995	DEC	32612.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1003.	1003.	108.	0.	31501.	69000.	41028.	1005.	0.	0.	0.	1005.
InlandAg	0	1995	TOT	42369.	0.	0.	0.	0.	61978.	0.	0.	61978.	0.	0.	64931.	64931.	7914.	0.	31501.	-1.	-1.	15981.	0.	0.	68.	15913.

Reservoir ID	Acc	Year	Mo	Initial Storage NA (1)	From River by Priorty (+) (2)	Storage (+) (3)	Other (+) (4)	Loss (-) (5)	From Carrier by Priorty (+) (6)	Other (+) (7)	Loss (-) (8)	Total Supply NA (9)	From Storage to River For Use (-) (10)	River For Exc (-) (11)	Carrier for Use (-) (12)	Total Release NA (13)	Evap (-) (14)	Seep & Spill (-) (15)	EOM Content NA (16)	Targt_0 Stor_n Limit NA (17)	BOM Decree Limit NA (18)	Station Balance River Inflow (+) (19)	River Release (+) (20)	River Divert (-) (21)	River by Well (-) (22)	River Outflow NA (23)
InlandAg	0	1996	JAN	31501.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	269.	269.	112.	0.	31120.	69000.	42139.	854.	0.	0.	0.	854.
InlandAg	0	1996	FEB	31120.	0.	0.	0.	0.	232.	0.	0.	232.	0.	0.	0.	0.	152.	0.	31201.	69000.	42520.	730.	0.	0.	0.	730.
InlandAg	0	1996	MAR	31201.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	709.	709.	286.	0.	30206.	69000.	42439.	663.	0.	0.	0.	663.
InlandAg	0	1996	APR	30206.	0.	0.	0.	0.	38677.	0.	0.	38677.	0.	0.	0.	0.	686.	0.	68198.	69000.	43434.	779.	0.	0.	3.	776.
InlandAg	0	1996	MAY	68198.	0.	0.	0.	0.	802.	0.	0.	802.	0.	0.	0.	0.	1252.	0.	67748.	69000.	5442.	673.	0.	0.	6.	667.
InlandAg	0	1996	JUN	67748.	0.	0.	0.	0.	1252.	0.	0.	1252.	0.	0.	0.	0.	1528.	0.	67472.	69000.	5892.	970.	0.	0.	3.	967.
InlandAg	0	1996	JUL	67472.	0.	0.	0.	0.	6168.	0.	0.	6168.	0.	0.	54187.	54187.	1382.	0.	18072.	69000.	6168.	3711.	0.	0.	14.	3697.
InlandAg	0	1996	AUG	18072.	0.	0.	0.	0.	10730.	0.	0.	10730.	0.	0.	13801.	13801.	765.	0.	14235.	69000.	55568.	3557.	0.	0.	20.	3537.
InlandAg	0	1996	SEP	14235.	0.	0.	0.	0.	30036.	0.	0.	30036.	0.	0.	0.	0.	616.	0.	43656.	69000.	59405.	2245.	0.	0.	1.	2244.
InlandAg	0	1996	OCT	43656.	0.	0.	0.	0.	4197.	0.	0.	4197.	0.	0.	0.	0.	513.	0.	47340.	69000.	29984.	1500.	0.	0.	0.	1500.
InlandAg	0	1996	NOV	47340.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1005.	1005.	208.	0.	46127.	69000.	26300.	1284.	0.	0.	0.	1284.
InlandAg	0	1996	DEC	46127.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1343.	1343.	130.	0.	44655.	69000.	27513.	1113.	0.	0.	0.	1113.

Operating Rule Information File (*.xop)

wwum2012.xop * | wwum2012.xre | wwum2012.xdd | WWUM2012_SW.ipy | WWUM2012.rsp | WWUM2012.opr

2007	0.	22.	0.	6.	36.	2344.	0.	0.	0.	0.	0.	0.	2409.
2008	0.	27.	39.	189.	758.	0.	3764.	5651.	222.	0.	0.	0.	10649.
2009	58.	63.	71.	78.	1126.	0.	4788.	0.	2449.	0.	0.	0.	8632.
2010	93.	20.	33.	32.	247.	484.	0.	0.	2480.	0.	0.	0.	3389.
2011	0.	0.	0.	666.	1117.	368.	0.	0.	2797.	0.	0.	0.	4948.
2012	0.	0.	103.	1745.	1633.	3212.	0.	0.	486.	0.	0.	0.	7179.
2013	0.	0.	0.	0.	522.	1624.	0.	0.	0.	0.	0.	0.	2147.
AVG	20.	50.	38.	89.	1000.	1717.	942.	928.	2454.	62.	57.	38.	7396.

Operational Right Summary ACFT

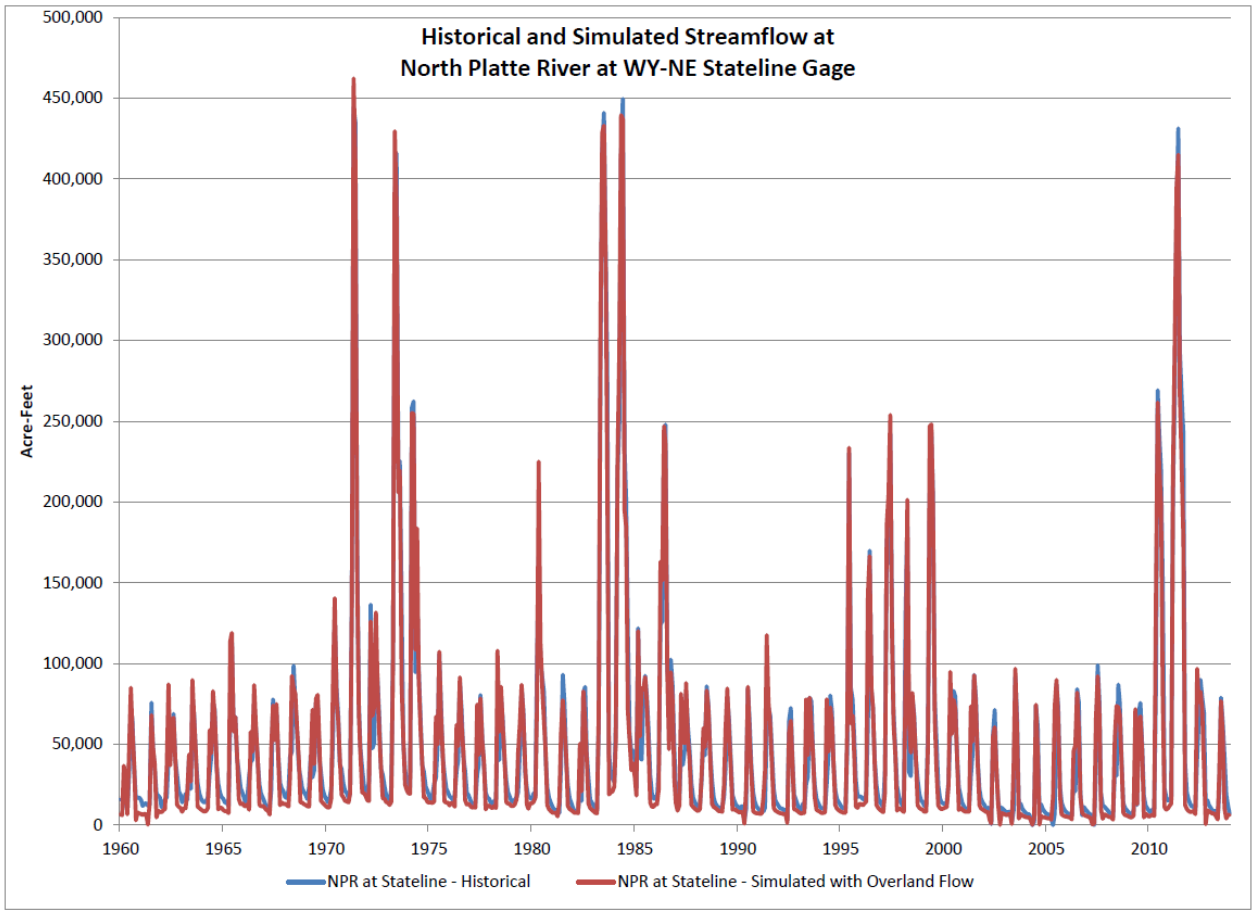
ID = 03966.121 Name = Direct_rights_to_03966_8 Opr Type = 11 Admin # = 1904.09190
Source 1 = 03966.02 Destination = 03966_84 Year On = 0 Year Off = 9999

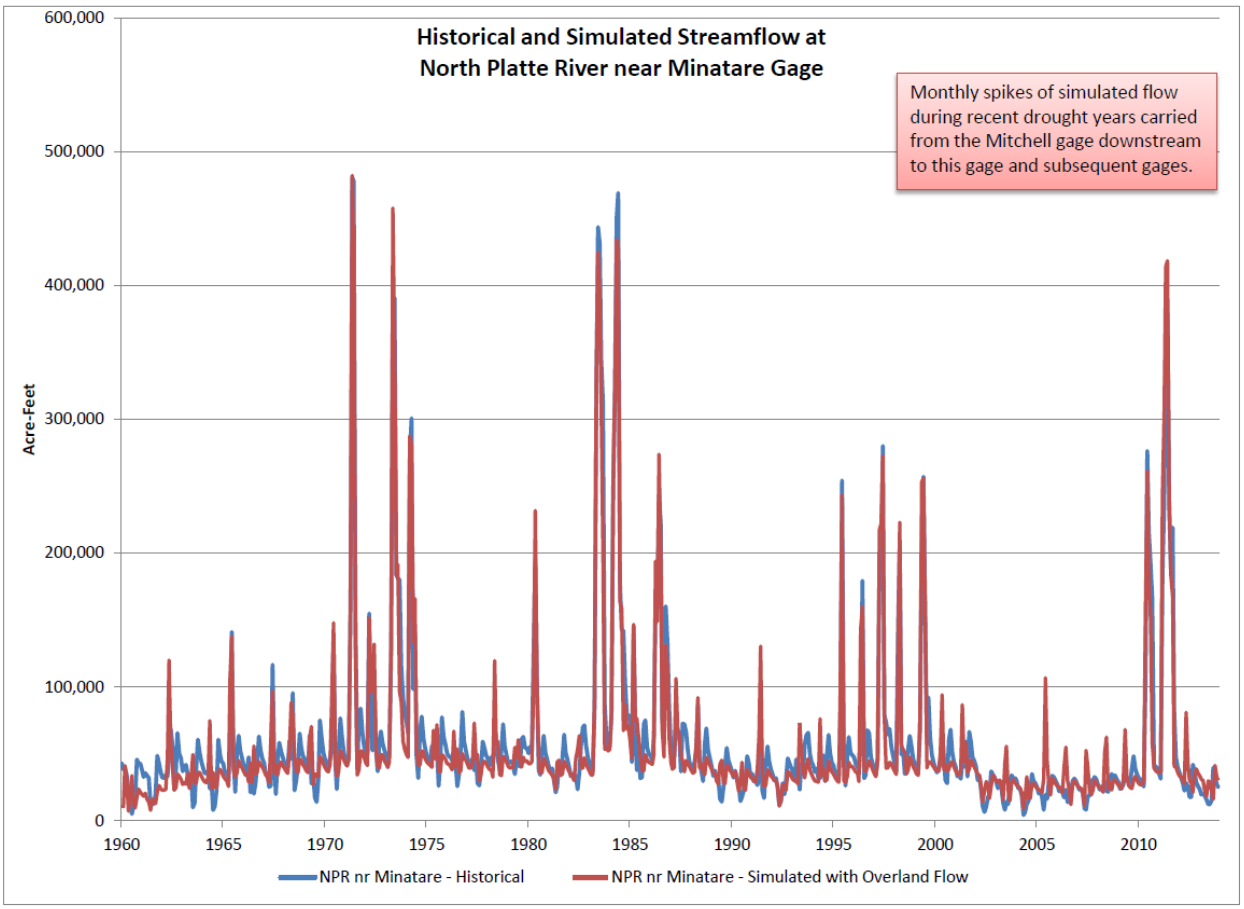
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1980	0.	0.	0.	101.	747.	1418.	0.	0.	1722.	0.	0.	0.	3988.
1981	0.	0.	0.	115.	1.	1557.	0.	0.	2010.	0.	0.	0.	3682.
1982	30.	0.	0.	16.	391.	173.	0.	0.	1525.	0.	0.	0.	2134.
1983	0.	0.	0.	2.	0.	885.	0.	0.	2108.	0.	59.	80.	3134.
1984	85.	83.	20.	0.	51.	1807.	0.	0.	1922.	0.	103.	96.	4166.
1985	87.	209.	31.	79.	1560.	1750.	0.	0.	1646.	0.	0.	0.	5362.
1986	0.	0.	54.	0.	1132.	916.	0.	0.	1587.	0.	256.	262.	4207.
1987	0.	0.	0.	0.	466.	710.	0.	4353.	1607.	0.	0.	0.	7136.
1988	0.	0.	31.	0.	783.	1050.	0.	0.	1803.	0.	0.	0.	3667.
1989	0.	0.	0.	192.	1418.	962.	0.	0.	1021.	0.	0.	0.	3592.
1990	0.	0.	0.	0.	0.	0.	0.	3715.	0.	0.	0.	0.	3716.
1991	0.	0.	0.	0.	0.	36.	0.	0.	1824.	0.	0.	0.	1860.
1992	0.	0.	4.	0.	0.	156.	3773.	0.	1381.	0.	0.	15.	5329.
1993	0.	0.	0.	68.	984.	23.	0.	0.	1324.	0.	0.	0.	2398.
1994	0.	0.	0.	229.	822.	2062.	0.	0.	1282.	0.	0.	0.	4394.
1995	0.	21.	0.	2.	0.	0.	0.	0.	2038.	0.	0.	0.	2061.
1996	0.	25.	0.	0.	86.	998.	0.	0.	1069.	0.	0.	0.	2178.
1997	0.	45.	156.	0.	796.	544.	0.	0.	2348.	0.	0.	0.	3889.
1998	0.	0.	25.	0.	154.	600.	0.	0.	1934.	0.	0.	0.	2712.
1999	0.	0.	0.	0.	392.	421.	0.	0.	761.	38.	0.	0.	1612.
2000	0.	0.	0.	0.	796.	2930.	0.	0.	1100.	0.	0.	0.	4825.
2001	0.	41.	24.	0.	742.	1160.	0.	0.	1139.	0.	0.	0.	3105.
2002	0.	0.	63.	18.	95.	1725.	0.	3318.	0.	0.	0.	0.	5218.
2003	0.	1.	0.	0.	158.	563.	0.	0.	0.	0.	0.	0.	721.
2004	0.	15.	0.	0.	223.	298.	1045.	3925.	0.	0.	0.	0.	5506.
2005	0.	39.	24.	0.	138.	187.	0.	0.	0.	0.	0.	0.	389.
2006	0.	16.	0.	51.	853.	801.	0.	0.	0.	0.	0.	0.	1721.
2007	0.	12.	0.	4.	21.	1360.	0.	0.	0.	0.	0.	0.	1397.
2008	0.	16.	22.	110.	440.	0.	0.	0.	0.	0.	0.	0.	588.
2009	0.	36.	40.	44.	634.	0.	2698.	0.	1380.	0.	0.	0.	4832.
2010	10.	12.	18.	18.	139.	272.	0.	0.	1393.	0.	0.	0.	1861.
2011	0.	0.	0.	447.	749.	247.	0.	0.	1876.	0.	0.	0.	3318.
2012	0.	0.	0.	1190.	1114.	2191.	0.	0.	332.	0.	0.	0.	4826.
2013	0.	0.	0.	0.	350.	1089.	0.	0.	0.	0.	0.	0.	1439.
AVG	6.	30.	22.	56.	605.	1003.	359.	316.	1469.	34.	34.	24.	3957.

Calibration Results

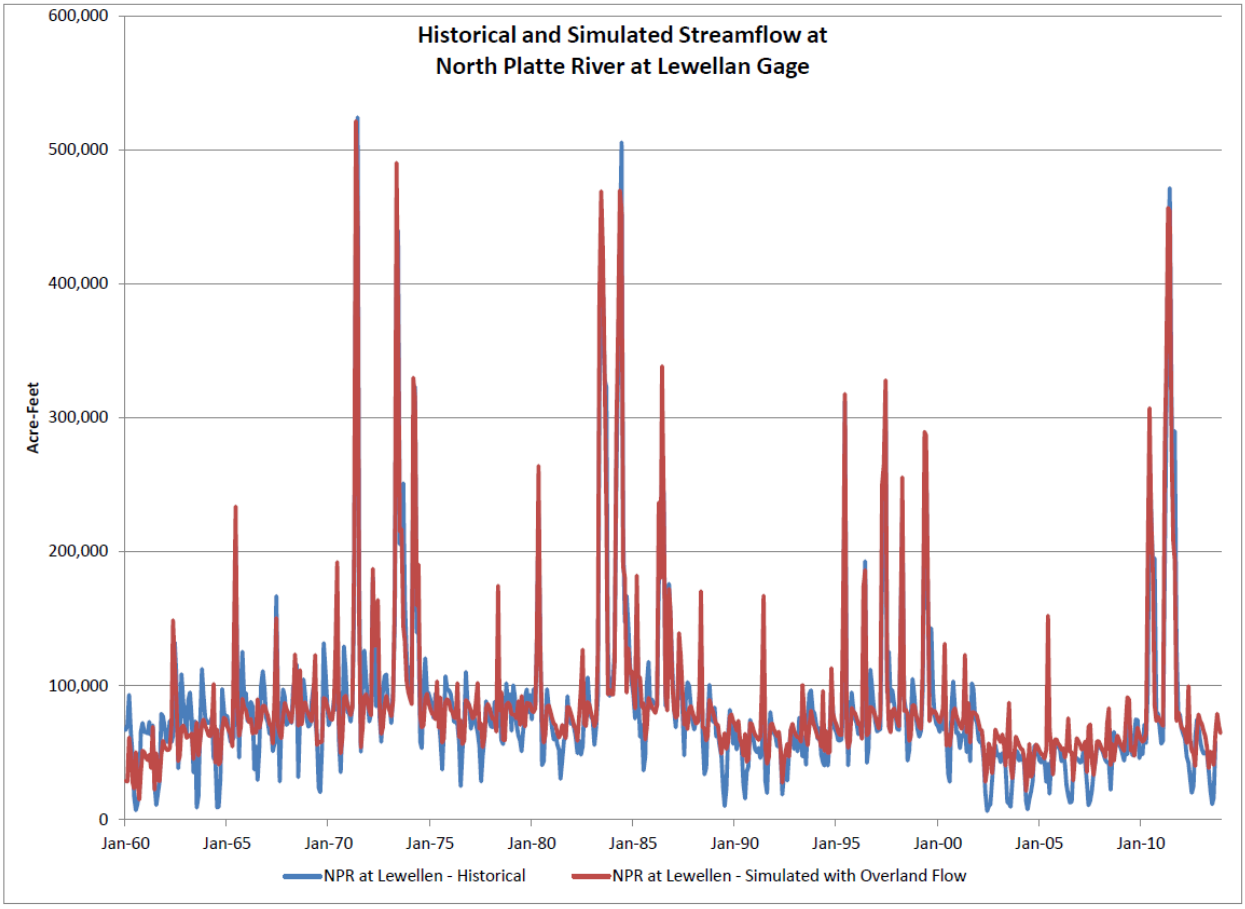
Calibration is the process of simulating the river basin under historical conditions and adjusting specific parameters to achieve agreement between gaged and simulated values of streamflow gages, reservoir levels, and diversions. Calibration of the WWUM Model was constrained due to the WWUM Model Integration components.

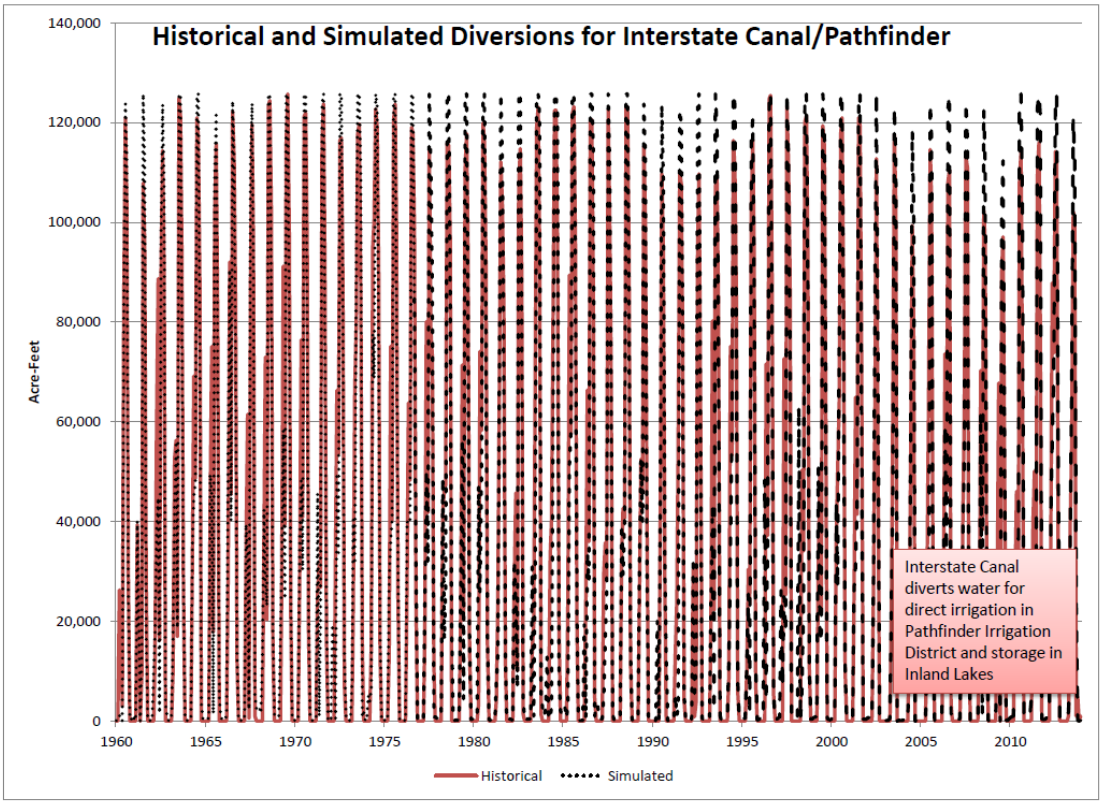
- Canal efficiencies
- Storage and release operations for the Inland Reservoir System
- Operational capacity and priority of carriers
- Locations were overland inflows accrued

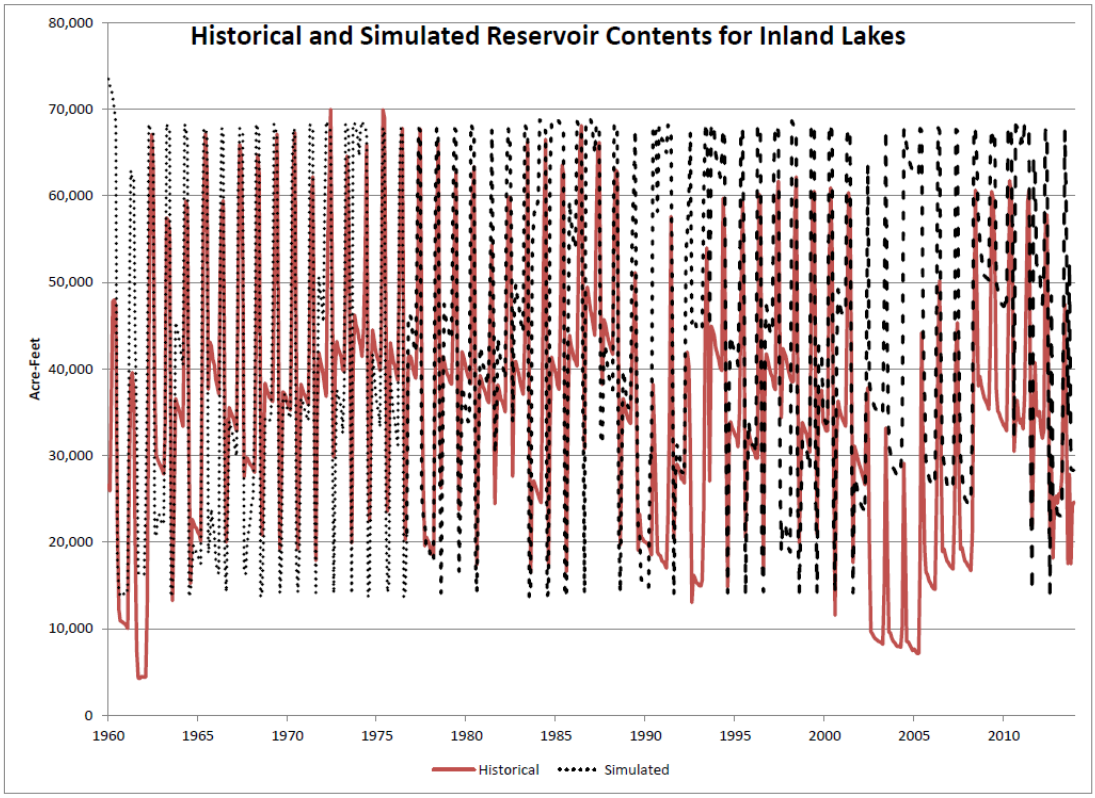


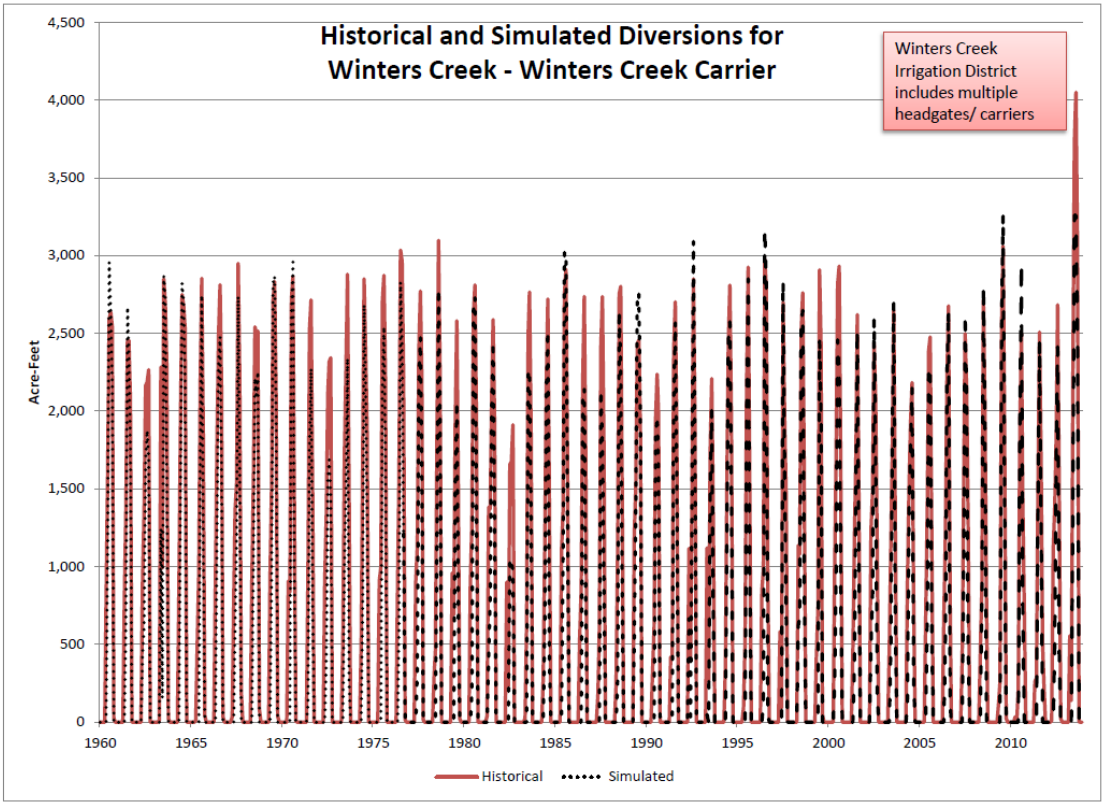


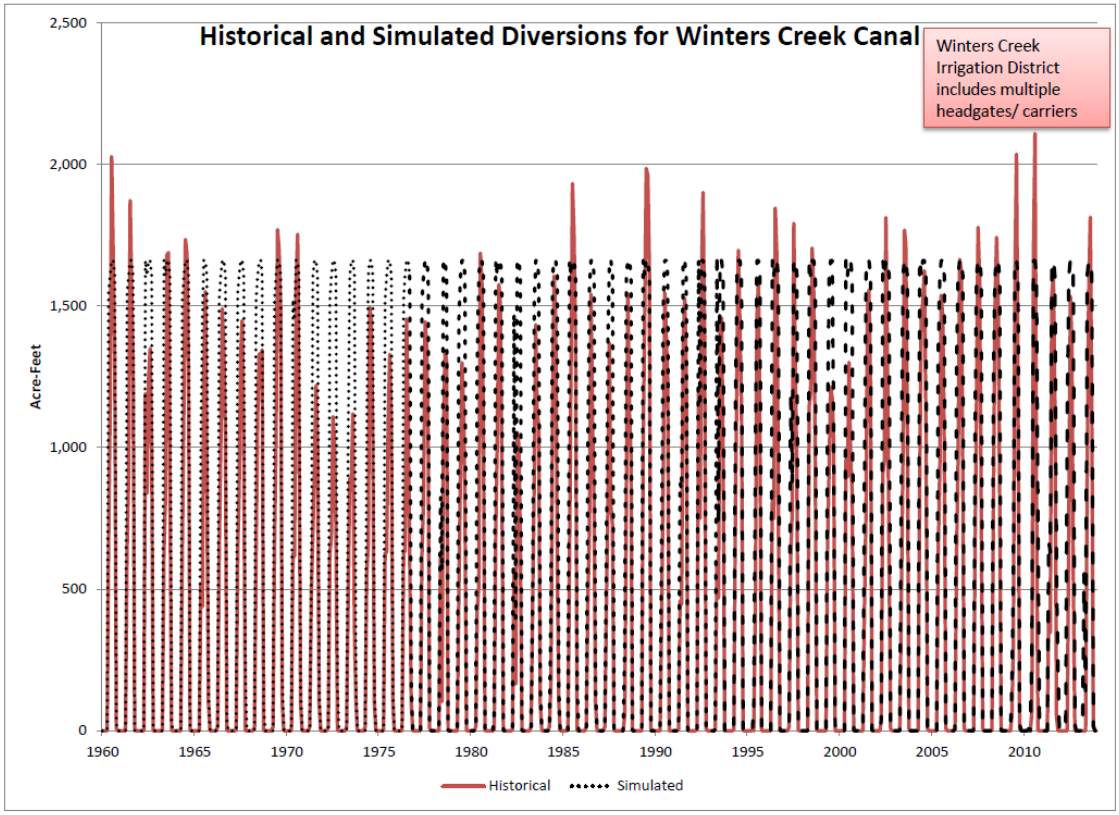
Calibration results for all gages, diversions, and reservoirs are provided on the CD in the back of the WWUM Water Resources Model User's Manual.


Historical and Simulated Streamflow at
North Platte River at Lewellan Gage
Acre-Feet
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-60
Jan-65
Jan-70
Jan-75
Jan-80
Jan-85
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
NPR at Lewellen - Historical
NPR at Lewellen - Simulated with Overland Flow


Historical and Simulated Diversions for Interstate Canal/Pathfinder
Acre-Feet
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Historical
Simulated
Interstate Canal diverts water for direct irrigation in Pathfinder Irrigation District and storage in Inland Lakes


Historical and Simulated Reservoir Contents for Inland Lakes
Acre-Feet
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Historical
Simulated


Historical and Simulated Diversions for Winters Creek - Winters Creek Carrier
Winters Creek Irrigation District includes multiple headgates/ carriers
Acre-Feet
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Historical
Simulated


Historical and Simulated Diversions for Winters Creek Canal
Winters Creek Irrigation District includes multiple headgates/ carriers
Acre-Feet
2,500
2,000
1,500
1,000
500
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Historical
Simulated

Discussion Topics and Future Scenarios

- Natural Flow vs. Storage Flow
- Surface Water "Call" and Use of Contract Water
- "What-if" Scenarios:
    - Change in Municipal Pumping
    - Increased/Decreased "Natural Flow"
    - Change in Efficiencies or Operations
    - Additional Downstream Demands
    - Augmentation/Recharge
    - Allocations